The EDITOR'S PAGE

Heating · Piping and Air Conditioning

The air conditioning system in the New York Curb Exchange building is arranged in such manner as to enable economies by careful operation. For instance, the trading floor system is in use until 3 p. m., while the clearing house system may be required to be in operation until

late in the evening; a cold water storage tank is therefore provided to furnish cold water for the clearing house equipment after 3 p. m. This eliminates the necessity of operating the refrigeration machine at a light load and consequent low efficiency.

Chester L. Nelson has described the conditioning equipment for this building in our lead-off article; the trading floor in the Exchange is one of the largest in the country.

Many of the speakers at the air conditioning conference to be held at *Case School of Applied Science* this month are well-known to the readers of HEATING, PIPING AND AIR CONDITIONING. A number of interesting-looking papers are to be presented, and the sessions are planned to cover principles of air conditioning, the unit processes and their control, health and comfort, and applications and economics.

The conferences, which are sponsored by Case and the *Cleveland Engineering Society,* are designed to afford the engineer a means of continuing his education. W. E. Wickenden, president of Case, summed up the need of the engineer for continually keeping in touch with new processes and developments in his opening remarks at a previous meeting. These are quoted in the editorial in this issue.

A mile-long underground line for conveying steam for process and power has been constructed by the Indianapolis Power & Light Co. to supply the Eli Lilly Company; a ten-year contract recently signed provides that steam (65,000 lb. per hr.) is to be delivered at 175 lb. and 100 F superheat. The steam will be used to generate electricity at the plant which will be fed into the utility's lines, the exhaust steam being used for process work. The construction of this line—the first of record required to deliver steam at 100 F superheat a mile from the boilers—is described by Robert L. Fitzgerald in this issue.

Direct-fired gas heaters are finding wider application in many localities; in this issue Platte Overton shows how the direct-fired heater for the offices of an industrial plant was selected and how the system was designed. Summer cooling is provided by passing city water through two sections of coils in the duct; in winter, the air is humidified.

E. H. deConingh wrote a letter to us last month from which we hasten to quote. "I do not know of any other technical journal among the many we receive," says Mr. deConingh, "which covers a field in as thorough and readable manner as does HEATING, PIPING AND AIR CONDITIONING."

WATCH FOR THESE NEXT MONTH

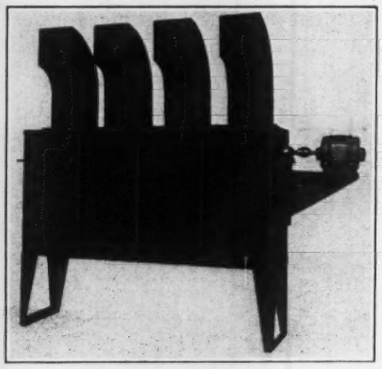
John J. Harman writes on testing methods for pipe joints in high pressure steam lines in the April number. A logarithmic chart showing turning moments required to produce various unit stresses in bolts of different sizes is of particular interest.

The third installment of Sabin Crocker's "Selecting the Right Size Heating Boiler" will be published in April. It discusses grate area and fuel burning rate, combustion space in furnace, type of heat liberation and the effect of these on sizing the boiler.

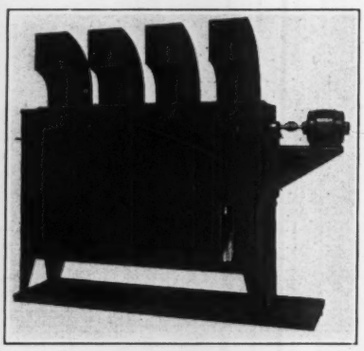
Malcolm Tomlinson has prepared a paper on calculations for drying which you'll find in next month's issue. Practical examples and charts make it of great value.

CLARAGE
UNIT EQUIPMENT

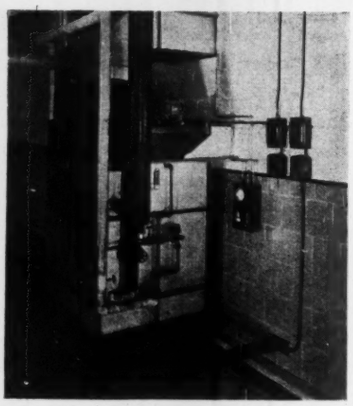
Whether your problem is heating, cooling or complete air conditioning—large or small job—this Clarage Unit Equipment is adaptable to your needs, and it offers both the advantage of improved performance and reduced cost.



UNITHERM UNIT HEATER



UNITHERM UNIT COOLER



UNIT AIR CONDITIONER

for HEATING

CLARAGE Unitherm Unit Heaters are a satisfactory and economical answer to any industrial heating requirement. Equipped with centrifugal fans, a Unitherm discharges heated air at high velocity. The result is uniform heating throughout the working zone—positive heating over wide areas. This greater efficiency provides comfortable temperatures with fewer units, less piping and fittings—a marked saving in cost. All working parts are readily accessible. The heating coil is good for pressures up to 200 pounds. The fans operate quietly. Write for Bulletin 81.

for COOLING

CLARAGE Unitherm Coolers will produce any low temperature desired, using brine or any direct expansion refrigerant. They are recommended for food, fur and other storage plants, for space cooling in process work, etc. The cool air, discharged at high velocity by centrifugal fans, quickly diffuses throughout the room. Thus a constant temperature is maintained at low cost. A Unitherm Cooler can be quickly installed with minimum piping and connections, saving labor and materials and eliminating costly wall coils or bunkers. All working parts are accessible. Write for Bulletin 77.

for HUMIDITY CONTROL

CLARAGE Unit Air Conditioners control moisture content as well as temperature—provide complete air conditioning. They will humidify or dehumidify as required, and have proved their economy in printing plants, paper, board and textile mills, chemical plants, warehouses, bakeries, laboratories, in tobacco factories, etc. A single unit will perfectly condition the air in one room or small department—a battery of units will handle an entire building. A Clarage Unit Conditioner eliminates a costly distribution system, offers greater flexibility, and invariably produces better results at a decided saving. Write for Bulletin 76.

CLARAGE FAN COMPANY
KALAMAZOO, MICHIGAN
Sales Engineering Offices in 32 Cities

TABLE OF CONTENTS

MARCH, 1932

Page

CONDITIONING SYSTEM PLANNED TO ENABLE OPERATING ECONOMIES 171
By Chester L. Nelson

SELECTING DIRECT-FIRED GAS HEATERS 176
By Platte Overton

MILE-LONG UNDERGROUND LINE SUPPLIES STEAM FOR PROCESS 180
By Robert L. Fitzgerald

REFRIGERATING SYSTEM COOLS AIR AND WATER, CONDENSES ALCOHOL, ETC 184
By Terry Mitchell

SELECTING THE RIGHT SIZE HEATING BOILER 186
By Sabin Crocker

PROCESS STEAM REDUCED THROUGH TURBINES SAVES IN COST OF POWER 193
By Francis A. Westbrook

TOTAL, STATIC AND VELOCITY PRESSURE 195
By A. A. Berestneff

KNOWLEDGE OF ELECTRICAL FUNDAMENTALS SAVES COSTLY MISTAKES 199
By Milton K. Arenberg

ASBESTOS CLOTH PROTECTS INSULATION ON PIPING NEAR BOILERS 201
By Wm. J. Deckman

GASKETS AND PACKING FOR HYDRAULIC POWER 202
By F. E. Wertheim

HEATED AND VENTILATED POULTRY HOUSES HAVE MANY ADVANTAGES 204
By Frederic L. Campbell

EDITORIALS 246

PUT VALVES UPSIDE DOWN? 247

"OPEN FOR DISCUSSION" 248

PRACTICAL PIPING PROBLEMS 249
By W. H. Wilson

ADVERTISERS' INDEX (Advertising Section) 122

JOURNAL SECTION OF A. S. H. V. E.

Room Warming by Radiation, by Arthur H. Barker 207

Proceedings of the 38th Annual Meeting 215

Bulletin Section 234

BOARD OF CONSULTING AND CONTRIBUTING EDITORS

Heating
Samuel R. Lewis
Alfred J. Offner
E. B. Langenberg
James C. Peebles
John D. Small
Homer R. Linn
Lee P. Hynes
Frederick D. Mensing
R. P. Schoenijahn
A. K. Ohmes
Samuel E. Dibble
J. C. Hornung
John D. Preble
A. Beaurrienne
T. S. Tenney
J. D. Hoffman

Piping
A. W. Moulder
Sabin Crocker
Lewis Lipman
E. O. Eastwood
A. R. Acheson
George B. Mulloy
J. J. Harman
C. W. Kimball

David J. Jones
Percy R. Owens
E. L. Ellingwood
R. C. Doremus

Air Conditioning
Dwight D. Kimball
Walter L. Fleisher
John Howatt

Frank B. Rowley
Alfred Kellogg
John F. Hale
E. P. Heckel
H. C. Murphy
Philip Drinker
R. S. Hawley
Charles S. Leopold
William A. Hanley

R. V. SAWHILL, *Editorial Director*
CHAS. E. PRICE, *Research Editor*
L. B. SPAFFORD, *Engineering Editor*
C. M. BURNAM Jr., *Associate Editor*

Published Monthly by **Engineering Publications, Inc.** 1900 Prairie Avenue, Chicago

TERMS OF SUBSCRIPTION

Anywhere in the world, except Canada, $3.00 per year. In Canada, $4.00.

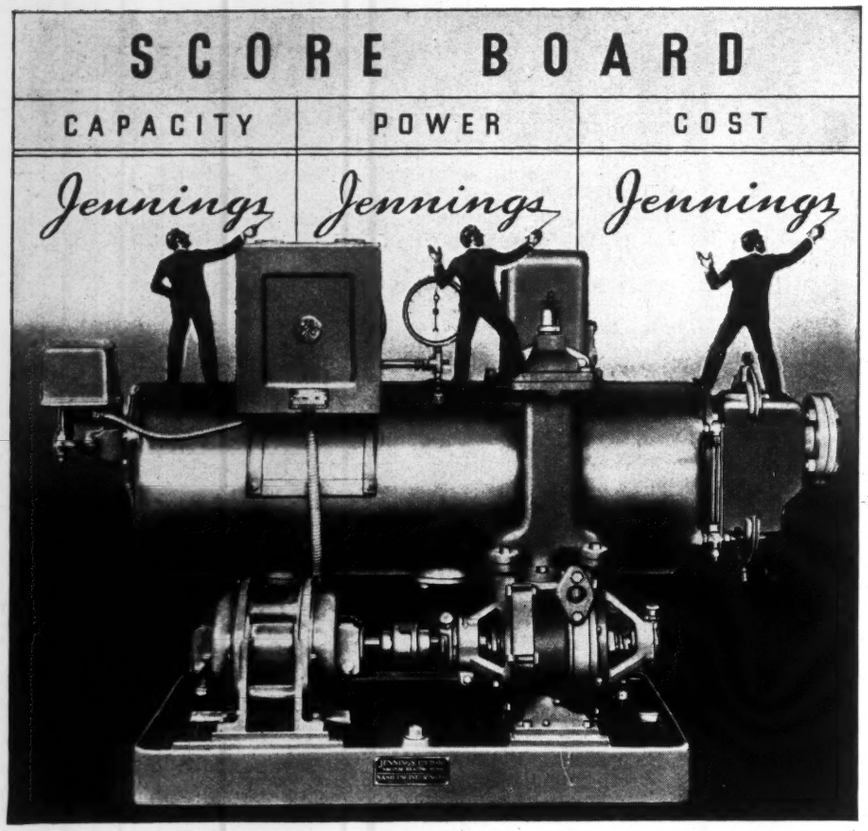
Current copies, 50c each. Back numbers, $1.00 each.

F. P. Keeney, *President and Treasurer*
E. DeForest Winslow, *Vice President*
O. T. Carson, *Secretary*

Address all Correspondence to Chicago Office.
New York Office, Room 1706-1707, 110 East 42nd Street.
Pittsburgh Office, Room 604, Chamber of Commerce Bldg.

Copyright 1932, by Engineering Publications, Inc.

MEMBER AUDIT BUREAU OF CIRCULATIONS



JENNINGS SCORES FIRST *on Every Count*

...gives you more for your heating pump dollar

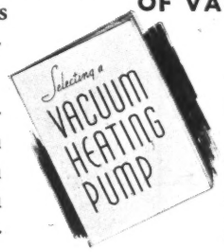
Today, more than ever before, dollar value is the first requisite of any piece of equipment. There is value without equal in Jennings Vacuum Heating Pumps.

These pumps are noted for their generous air and water capacities. If you buy pumping instead of a pump, your dollar invested in a Jennings will actually purchase the removal of more air and more water from the system in a given time.

Operating and maintenance costs, too, are less for Jennings Pumps. These efficient units consume less power; require less attention. They often serve 10 and 15 years without repairs or replacements of any kind.

When it comes to selecting a pump by ratings in square feet of radiation bear this in mind. You should also insist on a minimum power consumption and a definite air and water capacity in a given time. Then you will find that there's a Jennings Heating Pump to handle your job at a lower first cost.

BOOKLET DISCUSSES SELECTION OF VACUUM HEATING PUMPS



A new booklet, dealing with this problem in detail will be sent, on request, to anyone interested in obtaining more for his heating pump dollar.

NASH ENGINEERING COMPANY, 71 WILSON ROAD, SOUTH NORWALK, CONN.

Jennings Pumps

Heating · Piping and Air Conditioning

Vol. IV March, 1932 No. 3

Conditioning System Planned *to Enable* Operating Economies

By Chester L. Nelson*

MANY unusual and unique features both in construction and in operation are embodied in the air conditioning equipment for the New York Curb Exchange. The special conditions and problems encountered in dealing with this installation made necessary the design of equipment quite different in many respects from the usual air conditioning system.

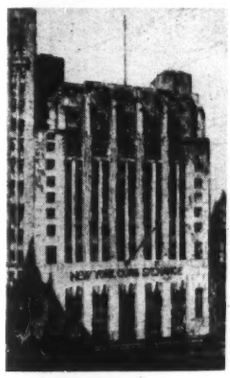


FIG. 1—IN KEEPING WITH THE MODERN TREND, AN AIR CONDITIONING AND COOLING SYSTEM IS INSTALLED IN THE NEW YORK CURB EXCHANGE BUILDING

New Section Added

In order to meet present demands and provide for future expansion a new 14-story section has been added to the old 6-story Exchange building. The difficult task of remodeling and combining the old building with the new section to produce a completely modern structure has been ably performed by the architects, engineers and builders[1]. In keeping with the modern trend, a complete cooling and air conditioning system has been provided for the enlarged board room or trading floor and for the clearing house.

Persons Major Source of Heat

The trading floor (shown in Fig. 2), one of the largest in the country, is located on the first floor, and has approximately 20,000 sq. ft. of area with a ceiling height of 63 ft. There are 28 trading posts, and when operating at full capacity it has an occupancy of 1,500 people. This heavy concentration constitutes a major part of the several sources of heat and moisture which were considered in the design of the air conditioning installation.

It is well established that heat and moisture dissipation by active people is greater than that from people at rest. Those who are familiar with trading floor operation know that there is a great deal of excitement and rushing about—in fact, a large percentage of the operators are extremely active. Careful allowance was made for this factor in the calculation of the estimated heat and moisture load. The other sources of heat and moisture considered in obtaining the total load were infiltration; sunlight gain through windows and walls; heat transmission through walls, windows, partitions, ceilings and floors; heat from lights and projection machines; heat transmitted from fans and pumps; and heat and moisture from the fresh and return air. In this connection, it might also be noted that the total heat load calculations were divided so as to separate sensible heat from the latent heat. This distinction is necessary because,

* Carrier Engineering Corp., New York City.
[1] Architects and Engineers, Starrett and Van Vleck, New York City; Builders, Thompson Starrett Co., Inc., New York City.

The air conditioning system for the new New York Curb Exchange building (opened last fall), is interesting in several respects, as the special conditions and problems encountered made necessary a design quite different in many respects from the usual installation. The system is arranged so that by careful operation, savings in power may be made. The operation and design are described thoroughly in Mr. Nelson's article.

in general, sensible heat is the determining factor for the amount of conditioned air to be supplied, while latent heat must be considered in the computation of refrigeration or dehumidification requirements.

The air conditioning equipment, designed to balance the above aggregate of heat sources, will maintain a temperature of 80 F dry bulb in weather having a 95-F dry bulb or 75-F wet bulb temperature, and also will maintain a relative humidity of 50 per cent when the outside wet bulb is 75 F. In winter it will heat the conditioned spaces will be maintained at all times, regardless of load fluctuations, without overcooling or overheating, aiding proper distribution and circulation. These factors effect savings in initial cost of equipment and cost of operation.

By referring to Fig. 4 it may be seen that each circulating system consists of a supply fan, a return and exhaust fan, filters, and heaters. Fans *S-2, S-3* and *S-4* supply a total of 100,000 c. f. m. of conditioned air to the trading floor. These three fans are of equal capacity,

FIG. 2—THE TRADING FLOOR, ONE OF THE LARGEST IN THE COUNTRY. THE CEILING ROSETTES FOR AIR INTRODUCTION ARE BLENDED WITH THE ARCHITECTURAL TREATMENT

conditioned spaces to 70 F when the outside temperature is zero.

Trading Floor Conditioning Equipment

The air conditioning apparatus is located on the sixth floor directly over the trading floor, the general arrangement being as shown in Fig. 3. Fan *S-1* delivers dehumidified air in summer and humidified air in winter from the one large dehumidifier or humidifier to three circulating systems (*S-2, S-3* and *S-4*) located in different sections of the floor. Fan *S-1* has a capacity of 40,000 c. f. m. and the dehumidifier sprays handle 670 g. p. m. of water which is pumped through the refrigeration machine cooler in the summer, and recirculated at the washer in winter.

One important feature in the design of this installation is the use of by-passed air. In general, the temperature differential between the conditioned air being supplied to the room and the room temperature is reduced by using by-passed air. The total air quantity handled is increased above that ordinarily required for humidifying or dehumidifying purposes, promoting adequate circulation without increasing the refrigerating or heating capacity. Still further, a constant supply of air to the delivering the air through duct systems to the diffuser outlets or rosettes arranged in the ceiling. Fans *E-2, E-3* and *E-4* have a total capacity of 80,000 c. f. m. divided equally between the three. These fans remove air from the trading floor through grilles located in the steps of the elevated tiers of telephone stands which extend the full length of the room on both the east and west sides, and also through grilles located in the bases of the trading posts. Connections from these fans then either return air to the dehumidifier, deliver air to the three supply fans (*S-2, S-3, S-4*) or exhaust air to the outside.

Equipment Arranged for Economies in Operation

The entire system has been arranged for flexibility in operation. An experienced operator can thus effect many economies by skillful operation of the equipment. Each circulating system (see Fig. 4) is connected with an auxiliary air intake from the outside and an exhaust connection so that when outside conditions permit (during intermediate seasons) the necessary inside conditions may be maintained without the use of refrigeration. The term "intermediate seasons" refers to those periods usually occurring in spring or fall in which no heating or

cooling is required. During the height of the cooling and dehumidifying season the auxiliary air connections are kept closed and a maximum of 20,000 c. f. m. of outside air is taken through the dehumidifier; this, however, may be increased to the full dehumidifier capacity of 40,000 c. f. m. during the lighter cooling and dehumidifying, or the heating and humidifying periods.

When the outside wet bulb temperature is below the apparatus dew point temperature necessary to maintain proper conditions, it is advisable to take the maximum available amount of outside air and no return air through the dehumidifier sprays. The reason is that air when passed through a water spray becomes saturated at its wet bulb temperature. In this way, the maximum effect of evaporative cooling is obtained with a consequent saving in refrigeration power.

Then again, there are periods during which it may be advisable to dispense with the use of sprays and to circulate 100 per cent outside air. Such periods occur when the outside dry bulb and dew point temperatures are such as to produce proper inside conditions without heating or cooling. In other words, the outside wet bulb temperature may be too high to produce proper delivery air temperatures by saturation of outside air through sprays, but still be low enough to maintain the proper room conditions if a sufficient quantity of outside air in an unsaturated condition is delivered by the supply fans. During these periods the operator can open wide the auxiliary air connections and exhaust outlets on *S-2, S-3* and *S-4* and shut down the refrigeration equipment, dehumidifier sprays, and Fan *S-1*.

Adequate Instruments Provided

Similar intermediate periods occur frequently during the year; therefore if the operator maintains an accurate balance between the operation of the equipment and the outside weather conditions, he will be able to save a considerable amount in operating costs. With this purpose in view, a complete set of instruments for the instantaneous reading of temperature conditions at various points has been installed to aid in keeping a close check on conditions at all times. By simply manipulating an assortment of push buttons the operator can obtain the wet and dry bulb temperature readings of the conditioned air being delivered to the room, of the air being returned from the room, and of the outside air being taken into the apparatus.

Air Filtered and Ionized

Air filters are provided so that all outside air taken into the system is freed of dust and dirt whether or not it is passed through the water sprays.

Ionization equipment is provided to operate in conjunction with the air distribution system with the object of absorbing any objectionable odors which may enter the air stream, and to maintain an ionized condition of atmosphere equivalent to that which is found to exist in outdoor air.

Room conditions are maintained by automatic controls which operate dampers and valves through a compressed air system. A double control of the dew point saturation temperature of the air leaving the dehumidifier or humidifier automatically takes care of the change from the heating and humidifying season to the cooling and dehumidifying period and eliminates the necessity for resetting the thermostats and automatic dampers.

Conditioning the Clearing House

The clearing house is located in the basement and has an area of approximately 4,170 sq. ft. of which about one-third has a ceiling height of 8½ ft. and the remainder about 13 ft. This room, of course, is not affected by sunlight or outside transmission effects so the major load is that from lights and people (150 people and 11,000 watts). There is, however, a large amount of heat transmitted through the floor as the machinery room is located directly underneath. In keeping with the general run of basement spaces, the lighting load is larger than that for upper floors.

The air conditioning apparatus, consisting of a spray

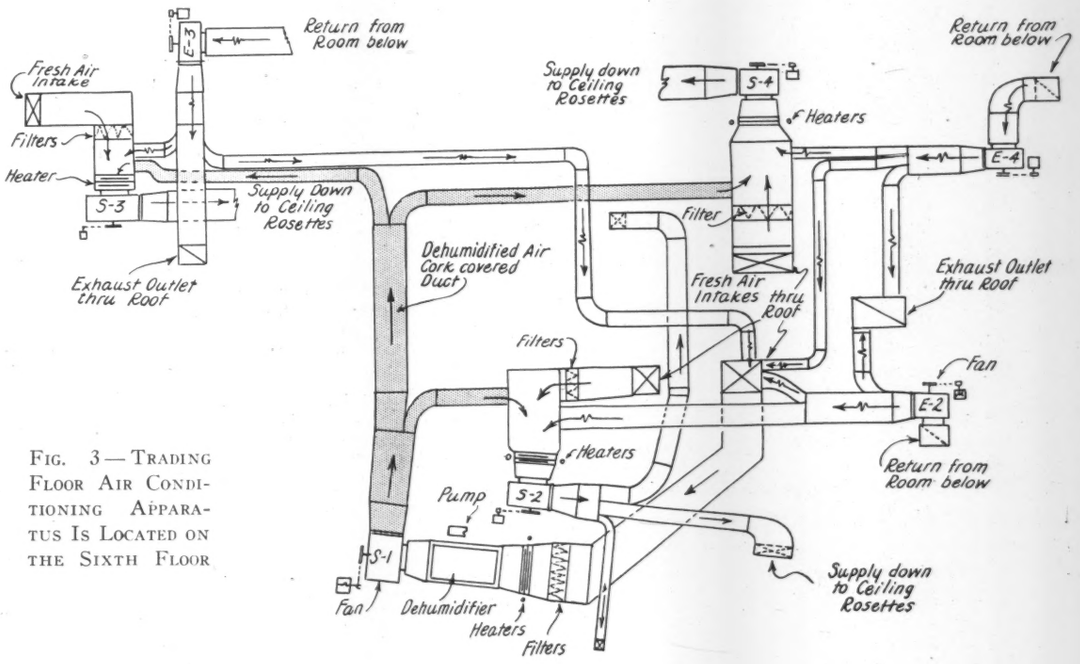


FIG. 3 — TRADING FLOOR AIR CONDITIONING APPARATUS IS LOCATED ON THE SIXTH FLOOR

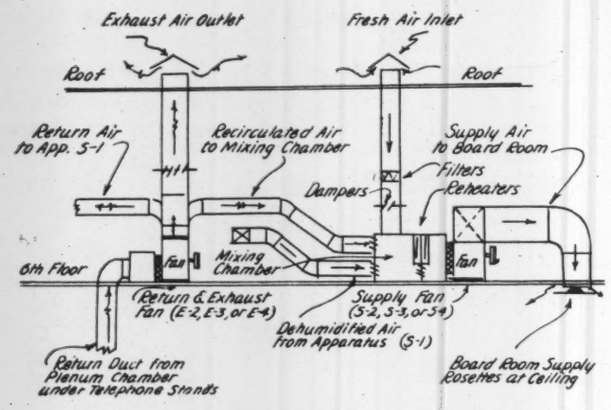


FIG. 4—DIAGRAMMATIC SKETCH SHOWING OPERATION OF A TYPICAL BOARD ROOM UNIT

chamber which serves as a dehumidifier or humidifier depending on the seasons, supply fan, return and exhaust fan, preheaters, reheaters, etc., is located on top of a large cold water tank in the machinery room. (The function of this tank will be explained later.)

Conditioned air is distributed in the clearing house by means of ceiling rosettes in the high section and side outlets in the 8½-ft. section. Return air is removed through grilles located in the base of columns on the north side and through bottom grilles in the south wall of the room. The supply fan has a capacity of 11,800 c.f.m., and the return fan, 9,500 c.f.m. with connections for returning or by-passing air; 57 g.p.m. of water are handled by the dehumidifier sprays.

Refrigeration and Water Piping

The refrigeration cycle is composed of five major parts: refrigeration machine, spray pond, storage tank, interchanger, and a bank of direct surface coolers.

Refrigeration Machine: The refrigeration machine is a unit consisting essentially of a shell and tube cooler and condenser and a multi-stage centrifugal compressor driven by a 350-h.p. variable speed motor. The machine has a capacity of 277 tons when cooling 670 g.p.m. of water from 49 to 39 F. The entire unit occupies a floor area of approximately 270 sq. ft.; maximum overall height is 10 ft.

In brief, the operation of the machine is as follows: The compressor discharges directly into the condenser where the refrigerant gas is condensed into a liquid which returns through a float valve and copper return pipe into the cooler. To the cooler casting is attached a liquid pump which handles the refrigerant from the bottom of the cooler up on to the spray deck in the top of the cooler casting. This spray deck is a perforated brass sheet set into the casting. The liquid refrigerant showers down over the tubes and collects in the bottom. The evaporation of the liquid cools the water and produces refrigerant gas which is taken into the compressor suction through a set of eliminator plates to separate any entrainment.

An evacuator or centrifugal vacuum pump is also attached to the cooler casting. The suction of this pump is taken from the condenser, and the discharge passing through a coil extending into the cooler discharges into a separation chamber and from there to atmosphere. This coil condenses the refrigerant gas handled by the pump into a liquid and returns it to the evacuator pump chamber. From this chamber it is re-admitted into the cooler through a float valve.

Two safety controls are provided, one depending on the temperature of the water and the other on the quantity of water passing through the cooler. With the first control, when a certain point is reached, the liquor pump automatically cuts off and stops refrigeration. The other control also cuts off the liquor pump depending on the quantity measured by means of an orifice plate and a pressure differential across the orifice controlling a flow switch.

When the machine is operating, both the high and low sides (condenser and cooler) are under a vacuum. The machine is readily susceptible to automatic control of the cold water temperature through regulation of the condenser water consumption.

Condenser Water; Spray Pond: Connections to the condenser are arranged so that the necessary cooling water may be taken from the city water mains or from a spray pond circuit. When the first source is used, the amount of water is automatically regulated in proportion to the load on the machine, effecting a saving in water cost. In this particular locality water is available from the city mains at a temperature not exceeding 70 F. When the present cost of city water is considered together with the total operating cost (including all capital charges and service charges) of the spray pond system, there is found to be very little difference in cost of operation. Neverthless, spray pond equipment has been included in anticipation of possible future shortage or increased cost. Increased security for continuous operation is also attained by the two condenser water sources.

The spray pond is located on the roof above the 6-story section of the building and has a capacity of 1,200 g.p.m. The system is guaranteed to cool the condenser water from 91½ to 81½ F with an outdoor 75-F wet bulb temperature and a 5-mile wind velocity.

Cold Water Storage Tank Cuts Cost of Refrigeration

Owing to the fact that the air conditioning system as a whole is not operated at its full capacity throughout the entire day, it was deemed advisable to make use of a cold water storage tank. The business hours for the trading floor are from 9 a. m. until 3 p. m., while the clearing house operates from 9 a. m. until all its work is finished, which may be late in the evening. At 3 p. m. the fans and pumps for the trading floor equipment are shut down and, consequently, a very light load would be imposed on the refrigeration machine if the system were allowed to operate under the normal full load operating cycle. This would lead to inefficient and turbulent operation, since the full load tonnage required for the clearing house is only 1/20 of that necessary for the trading floor. In other words the machine would be forced to operate at approximately 5 per cent of its full load capacity; for this reason, a storage tank is used.

The operation is as follows (refer to Fig. 5): At the start of a business day, valves *E, F,* and *G* are closed while *H* and *I* are opened. The water then passes from the pump P_1, through the refrigeration cooler, then in parallel flow through the clearing house interchanger, surface cooler (to be explained later), and by-pass up

to the board room dehumidifier sprays, after which the water is returned to the suction of the pump. The water in the clearing house circuit passes from pump P_2 through the pass in the interchanger into the dehumidifier sprays, and then returns to the pump suction.

After closing the trading floor at 3 p. m., valves H and I are closed while F and G are opened; then the water is diverted to the storage tank instead of through the trading floor dehumidifier and the full load of the refrigeration machine is taken in cooling down the water in the tank. The clearing house circuit remains the same as above.

The storage water will be cooled to a uniform temperature of about 40 F in approximately 45 minutes after which the refrigeration machine and pump P_1 are shut down and valve E is opened. The necessary cold water for the clearing house circuit is then taken from the storage tank.

The entire cycle at all times operates under closed circuit conditions, conserving pumping power because elevation head does not enter into the total head under which the pumps operate. Power is further conserved during the heating and humidifying periods by recirculating the spray water at the apparatus by means of pump P_3.

The storage tank is 28 ft. long, 11 ft.-10 in. wide and 6 ft.-4 in. high. It is constructed of 3/8-in. plate with all seams and joints welded; the entire surface is insulated with 2-in. of cork and plaster finish. Two equally spaced horizontal baffle plates and a vertical weir within the tank help to promote stratification of the warm return water so as to prevent mixing with the cold storage water in the lower portion of the tank. When filled to within nine inches of the top, approximately 1,900 cu. ft. or 14,300 gallons of cold water are contained, which is sufficient to operate the clearing house equipment for about four hours after shut down of the refrigeration machine. This means that the clearing house equipment will continue to carry its full load until 7 p. m.; if further cooling and dehumidifying is required, the refrigeration machine can be started and the storage tank again cooled.

Under all phases of operation, the proper temperature of chilled water being supplied to the dehumidifier sprays and to the surface cooler is automatically maintained by thermostats controlling the cold water mixing valves.

Interchanger Used During Day

During the day, when both the clearing house and trading floor equipments are in operation, or when the storage tank is being cooled, the cold water requirements for the clearing house circuit are automatically maintained by means of an interchanger. In other words, the cold water from the refrigeration machine is passed through one circuit of the interchanger and the water from the clearing house sprays is cooled to the proper temperature in the other circuit. Automatic temperature control is attained by regulation of the quantity of water passed through the interchanger from the refrigeration circuit.

Air for Pneumatic Tube System Dehumidified

An extensive pneumatic tube delivery system is used in connection with the operation of the trading floor. The blowers used have a capacity of 14,000 c.f.m. of air which is taken direct from the outside. Under ordinary circumstances such a large quantity of unconditioned air taken into the room would make impossible any attempt to maintain uniformity of temperature and humidity on the trading floor. For this reason the incoming air for the tube system is passed through a set of surface coolers which are a group of fin type coils, such as are ordinarily used for heating, enclosed in a casing with a drip pan underneath, and a set of eliminator baffles to catch any entrained moisture removed from the air. Heating coils are also incorporated in the casing for cold weather use. During the cooling and dehumidifying season all the air passing through the coolers is brought down to the dew point temperature being carried in the trading floor, so that when ejected into the room by the pneumatic tube delivery the effect on room conditions is slight.

Conclusion

All valves and other controlling devices have been so arranged as to be readily accessible to the operator so that little trouble will be experienced in performing the various stages of the operating cycle. Automatic control has been applied to all operating features to the fullest extent in agreement with practical limitations, but intelligent use of the aforementioned facilities for hand operation will effect many economies in operating costs.

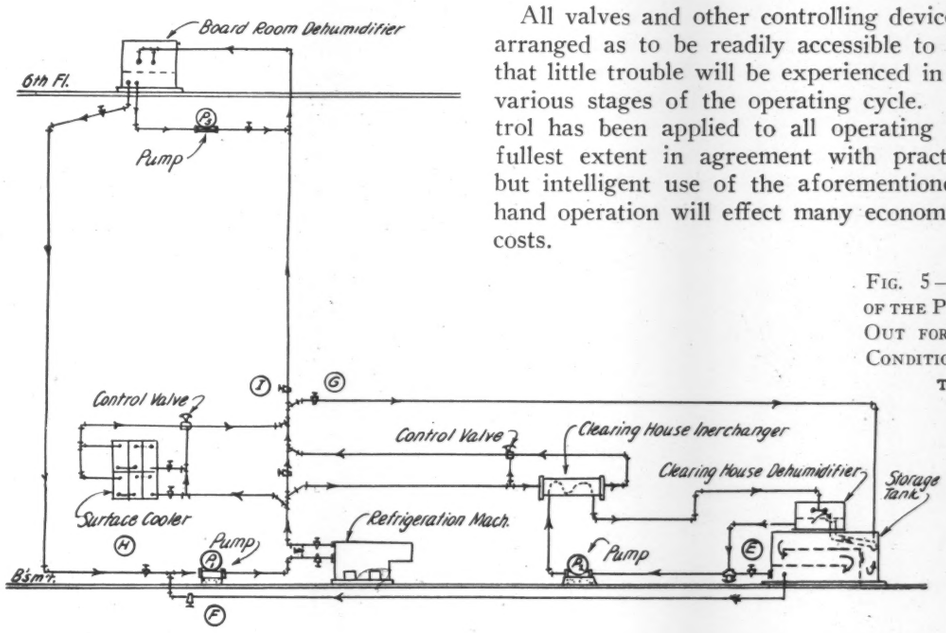


FIG. 5 — DIAGRAM OF THE PIPING LAY-OUT FOR THE AIR CONDITIONING SYSTEM

By Platte Overton*

Selecting Direct-Fired Gas Heaters

Factory Installation Illustrates Method of Determining Capacity

WITH reduced cost of gas for fuel, direct-fired gas heaters for indirect heating, ventilating and air conditioning find increasing application. Several of these units are available which contain not only the heating elements but the fan that forces the air over the heated sections and into the spaces to be conditioned. Some contain filters for the removal of dust and are equipped with humidifiers.

Gas Unit Heats Factory Offices

Such a unit has been installed in the offices of the factory shown in the accompanying plans. There are

* Consulting engineer, Chicago, Ill.

In many localities, where the cost of gas for heating has been reduced, direct-fired gas heaters for indirect heating, ventilating and air conditioning systems are finding wider application. In this article Mr. Overton has described the heating of a typical factory and its offices and tells how the heater was selected, how the ducts were sized, and how the other features of the design were made. The air supplied the offices is humidified and cleaned in winter; dehumidified and cleaned in summer.

TABLE 1—THE DATA SHEET, SHOWING THE COMPUTATION OF HEAT LOSSES

N 35 % NW 30 % NE 25 % W 20 % E 15 % SW 10 % SE 5 % S 5 %

Exposure Factors

Based on -10 °F. Cold Weather & Prevailing Winds From North West

Bldg. Office & Factory Date Aug. 6/31

Dist. No. or Loc. Twp. Co.

Bldg. H. & V.

Archt. Engr. Platte Overton

Rooms No.	*1	2	3	4	101	102	103	104	105	106	107		5	TOTALS
Use	Toilet	Entrance	Garage	Storage	Drafting Rm	office	office	office	office	office	office		factory	
MEASUREMENTS														
1. Room Dimensions													58 X 58	
2. Cubic Feet Space	2760	975	5900	1445	4700	390	1490	940	1130	960	560		165000	
3. Room Floor Area	276	78	590	117	470	39	149	94	113	96	56		5916	
4. Floor Const. & Factor	.52-1.8	.52-1.8	.52-2.5	.52-2.5	.44-36	.44-66	.44-96	.44-96	.44-66	.44-66	.44-66		.52-10	
5. Ceiling Const. & Factor					.60-24	.60-24	.60-24	.60-24	.60-24	.60-24	.60-24		.60-60	
6. Window Const. & Factor	.12-7.8	.12-7.8	.12-6.6	.12-6.6	.12-9.6	.12-9.6	.12-9.6	.12-9.6	.12-9.6	.12-9.6	.12-9.6		.12-9.6	
7. Wall Const. & Factor	.28-2.1	.28-2.1	.28-1.82	.28-1.82	.18-14.4	.18-14.4	.18-14.4	.18-14.4	.18-14.4	.18-14.4	.18-14.4		.18-21.8	
8. Exposed Sash and Door Perimeter, equiv.	24	13	15	14	10	10	60	10	50	42			350	
9. Leakage B. T. U. per ft. of Perimeter	70	70	50	50	70	70	70	70	70	70			50	
10. Expd. Wall Gross Area	115	160	805	138	340	60	250	90	260	120	100		5300	
11. Expd. Window Gross Area	30	30	280	42	60	20	60	18	80	36			1300	+ 1300 for Sky light
12. Expd. Wall Net Area	48	110	298	112	234	54	184	78	180	84	100		2308	
13. Exposure Direction	S	S	E	E	S N	N	E	E	S	S	S		S N E	
14. Room Temperature	65°	65°	55°	55°	70°	70°	70°	70°	70°	70°	70°		60°	
HEAT LOSSES														
15. Wall Loss B. t. u. per Hr.	1660	2310	5420	2038	3560	777	2650	1123	2592	1217	1940		63500	
16. Window Loss B. t. u. per Hr.	2802	2300	20362	1884	8928	576	6336	1152	9680	3936			234000	
17. Subtotal Loss B. t. u. per Hr.	4462	6210	25782	3612	12488	1353	8986	2275	10272	4618	1940		281500	
18. Expos. Allow. B. t. u. per Hr.	223	310	1860	543	620	414	2245	594	514	231	78		14500	
19. Floor Loss B. t. u. per Hr.	1380	616	3700	514		624	2080	920	860	634	1344		28000	
20. Ceiling Loss B. t. u. per Hr.					11280	6384	35000	22800	31920	23500	310		240000	
21. Leakage Loss B. t. u. per Hr.	1680	2310	6900	700	1500	700	4850	1200	6520	5980			17500	
22. Total Heat Loss	8115	10046	40240	5769	31138	3119	20625	6789	21066	10718	3227		630000	163728
23. Deduct for Heater Size												+ Sky light	122500	
24. Heater Building-loss Load													153000	
SERVICE														
25. Air Supply C. F. M.	130	160	640	92	510	60	330	124	334	172	52			2604
26. Recirculation C. F. M.														
27. Air Supply Inlet Temp.	135°	135°	135°	135°	135°	135°	135°	135°	135°	135°	135°			
28. Air Supply B. t. u. Service														
29. Direct Radn. B. t. u. Service														
30. Direct Radn. sq. ft.														
31. Grav. Ind. Radn. sq. ft.														
32. Aspir. Coils Radn. sq. ft.														

office section

EXPLANATORY NOTES

Steam Press. at Dir. Radrs. ..... lbs.
Steam Press. at Ind. Radn. ..... lbs.
Water Temp. at Radiators ..... ° F.
Hot Water Tank Cap. ..... Gals.
Recirc. Air Temp. at Heater .....
Misc.

ADDITIONAL HEATER LOADS

33. Piping Allowance E. D. R.		
34. Gravity Indirect Radiation and Aspir. Coils, E. D. R.		
35. Fan Indirect Radiation, E. D. R.		
36. Hot Water Tank Service, E. D. R.		
37. Outside Air Heat Loss, up to room temperature	86212	Office Section only
38. Recirc. Air Heat Loss, up to room temperature	32500	
39. Humidity Service	163728	
40.		
41. Total Heater Load	282500	
42. Chimney Size Required		

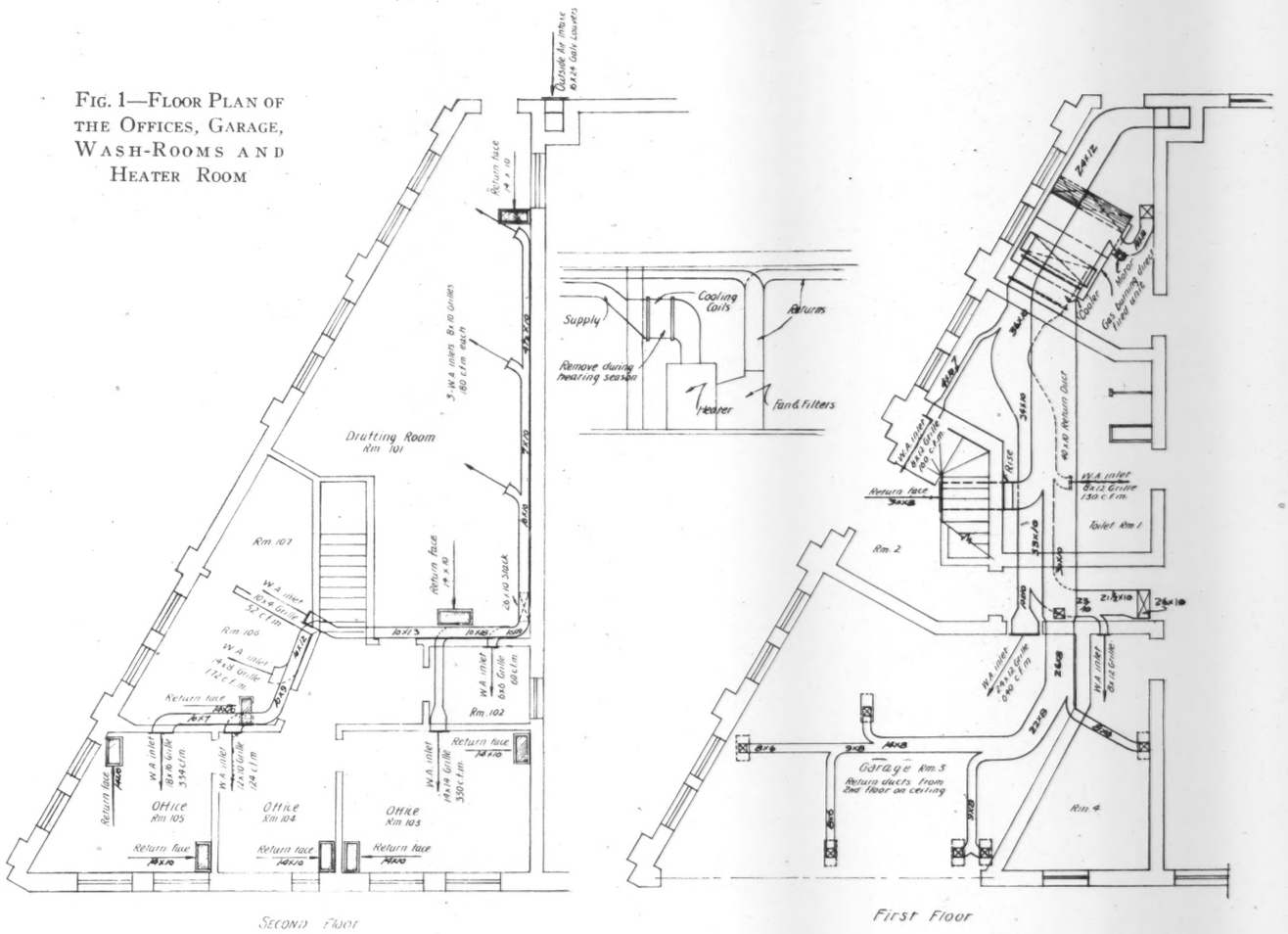


FIG. 1—FLOOR PLAN OF THE OFFICES, GARAGE, WASH-ROOMS AND HEATER ROOM

two floors; the lower contains the garage, wash-rooms, and heater room. The upper is occupied by offices and a large drafting room.

The total cubical content is 21,248. The structure is brick with steel windows. The total heat loss is 163,728 Btu per hr. at —10 F outside temperature. (See Table 1.) The inlet temperature at the grille is 135 F at the peak load.

Air from the offices is recirculated. Toilets, wash-rooms and garage have supply inlets but no exhausts. In these rooms leakage or ex-filtration removes the air in sufficient quantities to assure proper temperature and distribution.

In the offices, return grilles are placed in the floor. Inlets are over-head, just below the ceiling line. A total of 2,604 c.f.m. is supplied, maintaining an 8-min. air change. For the air exhausted by ex-filtration from the garage and toilets, outside air is supplied. This make-up air materially affects the fuel bill, but air from wash-rooms, toilets and garages cannot be recirculated without reconditioning. About 38 per cent of the air supplied is make-up.

Provisions for Cooling in Summer

Summer cooling is provided by the use of two sections of coils through which city water is passed. A special chamber was built in the supply duct to house these coils and they are connected to the water supply with common garden hose, allowing them to be removed during the heating season. A small opening in the base of the cooling chamber allows the moisture collecting on the coils to be forced out by the static pressure. Where much water is used the building supply may be "looped" through such coils and a steady circulation is maintained without additional cost for water.

During the heating season a spray humidifier maintains the correct relative humidity. A solenoid valve turns the water off or on when actuated by a humidity control instrument located in a central part of the upper floor.

Dust is removed by the cell filters located over the fan or blower. These filters contain a compressed steel-wool treated with a special oil compound. The filters, together with the fan, are an integral part of the heating unit.

Selecting the Heater

The temperature rise necessary for duty at the peak load is derived from the formula

$$t_m = \frac{R\,t_r + F\,t_t}{R + F}$$

where

t_m = temperature of mixture
t_r = temperature of return air
t_t = temperature of outside air
R = weight of return air in lb. per min.
F = weight of outside air in lb. per min.

Hence 2604 c.f.m. at 135 F = 173.8 lb. of air
38% of outside air = 67 lb. at —10 F
62% of return air = 106.8 lb. at +65 F

TABLE 2—EQUALIZATION OF PIPE DIAMETERS

This table shows the relation of the combined area of small round warm air ducts or pipes to the area of one large main duct. The figures at the top of the column represent the diameters of the small pipes or ducts; those in the left-hand vertical column are the diameters of the main pipes. The small figures show the number of small pipes that each main duct will supply.

EXAMPLE—To supply sixteen 10-inch pipes: Refer to column 10 at the top; follow down to small figure 16, thence left on horizontal line of the figure in the outside column, and it is found that one 30-inch main will supply air for the sixteen 10-inch pipes.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1																													
2	5.7	2																												
3	16	2.7	3																											
4	32	5.7	2.3	4																										
5	56	9.7	3.6	1.8	5																									
6	88	16	5.7	2.8	1.6	6																								
7	120	23	8.3	4.1	2.3	1.5	7																							
8	180	32	12	5.7	3.2	2.1	1.4	8																						
9		42	16	7.6	4.3	2.8	1.9	1.3	9																					
10		56	20	9.9	5.7	3.6	2.4	1.7	1.3	10																				
11			26	12	7.0	4.5	3.1	2.2	1.7	1.3	11																			
12			32	16	9.0	5.7	3.8	2.8	2.0	1.6	1.2	12																		
13			39	19	11	6.9	4.7	3.4	2.5	1.9	1.5	1.2	13																	
14			47	23	15	8.3	5.7	4.1	3.0	2.3	1.8	1.5	1.2	14																
15				27	16	9.9	6.7	4.8	3.6	2.8	2.2	1.8	1.4	1.2	15															
16				32	18	11	7.9	3.7	4.2	3.2	2.6	2.1	1.7	1.4	1.2	16														
17				37	21	13	9.2	6.6	4.9	3.8	2.9	2.4	2.0	1.6	1.4	1.2	17													
18				43	24	16	10	7.7	5.7	4.3	3.4	2.8	2.3	1.9	1.6	1.3	1.2	18												
19				49	28	18	12	8.8	6.5	5.0	3.9	3.2	2.6	2.2	1.8	1.5	1.3	1.2	19											
20				56		20	14	9.9	7.4	5.7	4.5	3.6	2.9	2.5	2.1	1.7	1.5	1.3	1.1	20										
21				61		22	15	10	8.4	6.3	5.2	4.1	3.2	2.6	2.3	2	1.6	1.4	1.2	1.1	21									
22				71		26	18	13	9.3	7.2	5.7	4.5	3.7	3.1	2.6	2.2	1.9	1.7	1.4	1.3	1.1	22								
23				77			20	14	10	7.8	6.2	5	4.1	3.4	2.8	2.4	2.1	1.8	1.6	1.4	1.2	1.1	23							
24				88			22	16	12	8.9	7.6	5.7	4.6	3.8	3.2	2.9	2.4	2.1	1.8	1.6	1.3	1.2	1.1	24						
25				97			24	17	13	10	8.0	6.4	5.2	4.2	3.5	3.1	2.6	2.2	2	1.7	1.5	1.3	1.2	1.1	25					
26				108			27	19	14	11	8.6	6.9	5.7	4.7	4	3.4	2.9	2.5	2.2	1.9	1.7	1.5	1.3	1.2	1.1	26				
27				121				21	15	12	9.6	7.5	6.1	5.1	4.3	3.6	3.1	2.7	2.4	2.1	1.9	1.6	1.5	1.3	1.2	1.1	27			
28				129				23	17	13	10	8.3	6.8	5.7	4.8	4.1	3.5	3	2.6	2.3	2.1	1.8	1.6	1.5	1.3	1.2	1.1	28		
29				141				25	19	14	11	9.1	7.5	6.2	5.2	4.4	3.8	3.3	2.9	2.5	2.2	2	1.8	1.6	1.4	1.3	1.2	1.1	29	
30				151				28	20	16	12	9.9	8	6.7	5.7	4.7	4.1	3.6	3	2.6	2.4	2.2	1.9	1.7	1.5	1.4	1.3	1.2	1.1	30
31				168				30	22	17	13	10	8.9	7.4	6.1	5.1	4.5	3.9	3.4	3	2.7	2.4	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1.1
32				184				32	23	18	14	11	9.3	8.0	6.5	5.7	4.8	4.2	3.7	3.2	2.8	2.5	2.3	2	1.9	1.6	1.5	1.4	1.3	1.1
33				196				35	25	19	15	12	10	8.5	7.1	6.0	5.2	4.4	3.9	3.5	3	2.7	2.4	2.2	2	1.8	1.6	1.5	1.3	1.2
34				212				37	27	21	16	13	11	9.1	7.6	6.4	5.5	4.8	4.2	3.7	3.3	2.9	2.6	2.4	2.1	1.9	1.7	1.6	1.5	1.3
35				229				40	30	23	18	14	12	10	8.4	7.1	6.1	5.3	4.6	4	3.5	3.1	2.8	2.5	2.3	2.1	1.9	1.7	1.5	1.4
36				242				43	32	25	19	16	13	11	8.9	7.6	6.5	5.7	5	4.3	3.7	3.4	3	2.7	2.4	2.2	2	1.9	1.7	1.6
37				260				45	33	26	20	16	13	11	9.3	7.9	6.9	6	5.3	4.6	4	3.6	3.2	2.9	2.6	2.3	2.1	1.9	1.8	1.6
38				279				49	37	29	22	18	14	12	10	8.6	7.4	6.3	5.5	4.8	4.3	3.8	3.4	3.1	2.8	2.5	2.3	2.1	1.9	1.8

$$\frac{67 \times (-10) + 106.8 \times 65}{173.8} = +36 \text{ F (approx.) for } t_m \text{ or a}$$

100 F temp. rise.

Hence, the total Btu load is

$$2604 \times 60 \times 0.24 \times 0.06675 \times 100 = 250{,}000 \text{ Btu}$$

A heater with an *A. G. A.* Btu input of 350,000 was selected. With 75 per cent efficiency this heater will carry the load satisfactorily.

No duct heat loss was calculated as all supply ducts are run in rooms where a 65-F temperature, or more, is maintained.

Determining the Inlet Temperature

On the data sheet it will be noted that each room has a definite supply of air in cubic feet per minute. This volume is based on the required c.f.m. at 135 F to offset the Btu loss of the room served. Rooms with considerable exposure and glass area have necessarily rapid air changes, as in room *103*.

Due to the fact that there is but one trunk line, and therefore one temperature of supply air, the inlet temperature is a factor in the design or calculation of the system. Rooms with a comparatively high heat loss must have a high inlet temperature or too large a volume of air for comfort will be necessary. The writer, however, believes that 135 F should be a maximum, and that 120 F is better.

In this installation an inlet temperature of 120 F in room *103* would mean over 400 c.f.m. or a 4-min. air change and is too high. With a trunk line system it is necessary to make a preliminary survey of the requirements before the inlet temperature and the air volume can be decided on. With the individual run to each room and temperature control of the air in each duct the calculation for the room may be based on a definite volume of supply air and the inlet temperature allowed to vary as it may.

Duct Sized to Resistance

The trunk duct for this job was designed to resistance. With this method, the velocity in the main is first established. This will vary with the size of the main and the c.f.m. Following is a list of volumes in cubic feet per minute and the velocity as recommended by the writer:

800 c.f.m.; total velocity 900 f.p.m.
1000 c.f.m.; total velocity 950 f.p.m.
1200 c.f.m.; total velocity 1000 f.p.m.
2000 c.f.m.; total velocity 1150 f.p.m.
3000 c.f.m.; total velocity 1250 f.p.m.
4000 c.f.m.; total velocity 1350 f.p.m.
5000 c.f.m.; total velocity 1425 f.p.m.

All the above volumes in ducts 100 feet long would have approximately the same pressure loss.

As the volume in this problem is 2,604 c.f.m., 1,200 f.p.m. is chosen as the velocity in the main near the heater and 2.18 sq. ft. of duct (2,604 ÷ 1,200) or a 20-in. round duct, approximately, is required. All the calculations were made in terms of round ducts and changed to equivalent rectangular ducts.

Referring to Table 2 it is seen that one 20-in. duct is equal to 56 4-in. ducts for equal pressure loss. The first branch to room *2* is to supply 160 c.f.m. The percentage of the total then becomes 160 ÷ 2,604 = 6.15 per cent. 6.15 per cent of 56 = 3.44 4-in. ducts and from Table 2 it is seen that 3.44 falls between 6 and 7 or a duct 6½ in. in diameter.

The main then continues with 93.85 per cent of 56 4-in. ducts, which equals 53 4-in. ducts, which equals a

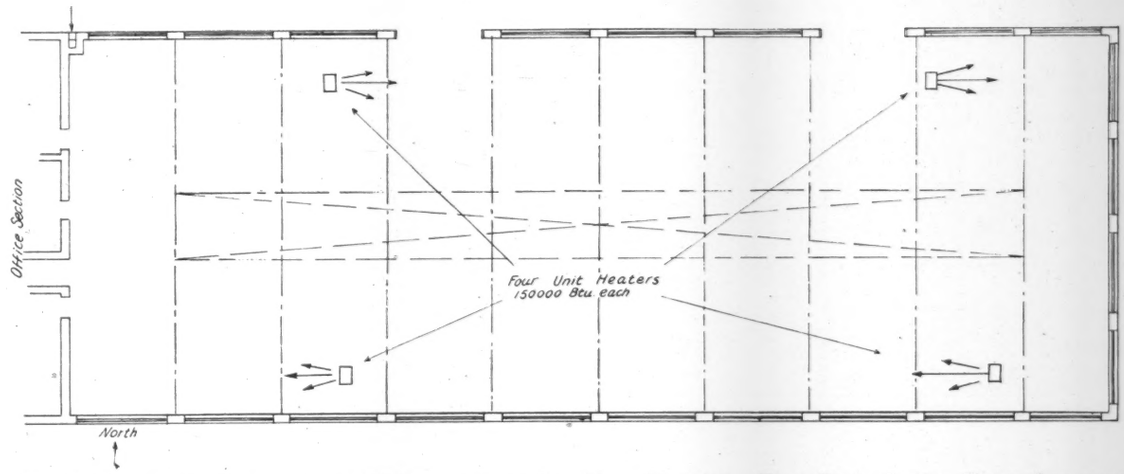


FIG. 2—THE FACTORY SECTION IS HEATED BY FOUR GAS UNIT HEATERS. THIS PLAN SHOWS THEIR LOCATION

19½-in. round duct. The next branch is to supply 130 c.f.m. and its size is determined in like manner. Ducts designed and sized in this manner require no volume dampers; however, dampers may be installed and left wide open in case of doubt.

The factory section, which is 60 ft. x 160 ft., with an average height of 18 ft., is heated by four gas unit heaters, rated at 150,000 Btu input with 900-Btu gas. The data sheet shows a requirement of 753,000 Btu at the peak load (—10 F outside temperature). By-product heat from forges, torches, and lights compensates for the difference in the requirements and the maximum heater input.

Due to the 18-ft. ceiling height, the mean temperature is high. Sixty degrees at the breathing line gives a mean temperature of 68 F.

Symposium on Welding Published

The *American Society for Testing Materials,* 1315 Spruce st., Philadelphia, Pa., has recently published the "Symposium on Welding"; this symposium was held at the regional meeting of the Society last March. Eleven papers—together with the discussions—appear in the 152-page book, which is priced at $1.75.

A major portion of the symposium treats with the testing of welds and welded products. One author discusses extensively the stethoscope method of weld testing. Magnetographic inspection and magnetic weld test meters are described as well as other types of magnetic testing apparatus. The utilization of X-ray equipment for welding as carried out at the Watertown Arsenal is fully discussed. The use of gamma rays is described by an authority.

Fatigue testing gives a good method for determining welding process quality, according to the opinion of one welding authority, who also discusses impact testing of welded products. The characteristics of good and bad welds are described in the paper which discusses welding inspection and actual inspection practice.

The following papers are included: General Survey of Welding Processes, F. T. Llewellyn; Welding Processes Applicable to Aluminum, W. M. Dunlap; The Quality of Materials for Fusion Welding, C. R. Texter and F. N. Speller; Modern Application of Arc Welding, A. M. Candy; Recent Developments in Gas Welding and Cutting, E. J. W. Egger; Stethoscopic Examination of Welded Products, J. R. Dawson; Tests of Welding Made by the Watertown Arsenal, G. F. Jenks; Gamma-Ray Testing of Welds, G. E. Doan; Magnetic Methods of Testing Butt Welds, T. R. Watts; Fatigue and Impact Testing of Welded Products, T. M. Jasper; Welding Inspection, R. Kraus.

Center-to-Face Dimensions for Ferrous Flanged Valves

The center-to-face dimensions for ferrous flanged valves recently developed and approved by the *Manufacturers Standardization Society of the Valve and Fittings Industry* as standard practice have been tentatively recommended for adoption as an American Standard by subcommittee No. 5 of the sectional committee on the standardization of pipe flanges and fittings. This proposal sets forth the center-to-face dimensions of cast iron and steel flanged valves of the wedge gate, globe and angle types for several pressures and over a considerable range of sizes. When adopted it will facilitate the replacement of valves in existing piping systems.

The following valves are included:

Flanged Wedge Gate Valves		Flanged Globe Valves		Flanged Angle Valves	
Cast Iron		*Cast Iron*		*Cast Iron*	
Lb.	*In.*	*Lb.*	*In.*	*Lb.*	*In.*
125—	2 to 24	250—	2 to 6	250—	2 to 6
250—	2 to 24				
Steel		*Steel*		*Steel*	
150—	2 to 24	300—	2 to 6	300—	2 to 6
300—	2 to 12	400—	4 to 8	400—	4 to 8
400—	4 to 24	600—	½ to 8	600—	½ to 8
600—	1 to 24	900—	3 to 8	900—	3 to 8
900—	3 to 24	1500—	1 to 8	1500—	1 to 8
1500—	1 to 12				

This tentative proposal is being distributed to interested engineers for criticism and comment; after receipt of these comments the subcommittee will formulate a definite recommendation for submittal to the sectional committee. Requests for detailed information should be addressed to C. B. LePage, assistant secretary, *A. S. M. E.,* 29 W. 39th St., New York City.

MILE-LONG UNDERGROUND LINE SUPPLIES STEAM . . . FOR PROCESS . . . . . .

By . . . . .
Robt. L. Fitzgerald*

DEMAND for steam of high pressure and high temperature has prompted the construction by the Indianapolis Power & Light Company of an underground, high-pressure steam line that in many ways will establish a new and unique service.

The immediate reason for this line is a recently signed ten-year contract with Eli Lilly Company to supply all of the steam requirements of its plant. The contract provides that the steam shall be delivered at a pressure of not less than 175 lb. and with not less than 100 F of superheat, when steam consumption is 65,000 lb. per hr. or higher. Present demand for steam is specified as 65,000 lb. per hr. The yearly consumption of steam will be 325,000,000 lb., an average of about 900,000 lb. per day.

Steam Is Conveyed One Mile

The steam is to be supplied from the Kentucky avenue steam generating station at Kentucky avenue and South streets. The point of delivery is at Delaware and McCarty streets, about a mile from the generating station. Initial steam condition at the boilers is 250 lb. pressure and 200 F superheat. As the ability of any line to deliver superheated steam depends on the velocity of the steam in the line, no attempt is made to assure any specified superheat conditions during periods of low flow in the line. While there are many miles of underground high pressure steam lines in existence, this is the first line, of record, that is required to deliver 100 F of superheat over one mile distant from the boiler plant. Successful performance of this line will establish the long distance distribution of high temperature steam as a physically possible and economically advantageous method of furnishing high temperature heat for many commercial and industrial purposes, it is expected.

*Manager, steam heating department, Indianapolis Power & Light Company, Indianapolis, Ind.

Factors Affecting Size of Line

Because of the severe operating requirements of the line every precaution has been taken in its design and construction. To design and construct a line to meet just the present conditions as to quantity, pressure and temperature of steam would be comparatively easy. However, it would be poor engineering to construct a mile of pipe through such a choice industrial district without allowing spare capacity for the additional business that now exists and will develop along the line. In addition to the available industrial business that can be served, its location is such that a short extension of pipe will permit it to be used as a booster to the present low-pressure distribution system. The determination of the size of the line became a matter of selecting the largest size that would provide for additional capacity and still be small enough to maintain sufficiently high steam velocity for present steam quantities to assure guaranteed terminal superheat.

Additional Business Will Result in Increased Superheat at Terminal

After detailed calculation of numerous line sizes and combinations of line sizes, the decision was made to use 16-in. O.D. pipe for the first 2,600 ft. that is located in South street and will be required to serve most of the future load. The remainder of the line will be 10-in.

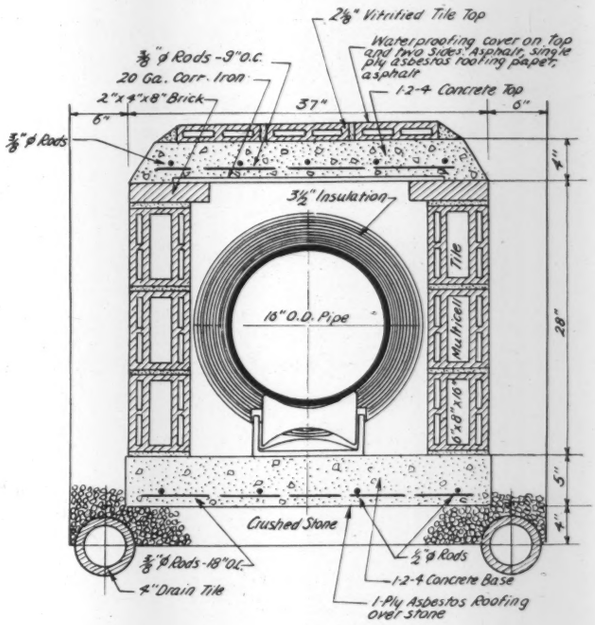
These sizes permit a velocity for initial maximum load conditions of about 2,100 ft. per min. in the 16-in. section and about 4,600 ft. per min. in the 10-in. section, delivering steam to the customer a mile away 1½ min. after leaving the boilers. As additional business is connected to the line, the velocity will increase and with it the terminal superheat will increase above the minimum requirements, while the pressure will move down to the minimum contract requirements of 175 lb. There is additional industrial business adjacent to the line amounting to 100,000 lb. of steam per hr.

Construction Details

Location: The sub-soil in Indianapolis is generally a sandy gravel that affords excellent drainage and offers about as favorable conditions for underground steam construction as is found anywhere in the country. Changes in surface grade are in general gradual and surface drainage is good, except in cases where streets are depressed under railroad elevations. The route chosen for the line was picked to avoid any such depressions where water stands in the street under heavy rain conditions. The location of the line in the street is under the sidewalk or in the parkway, this location being chosen because it was relatively free from other underground structures.

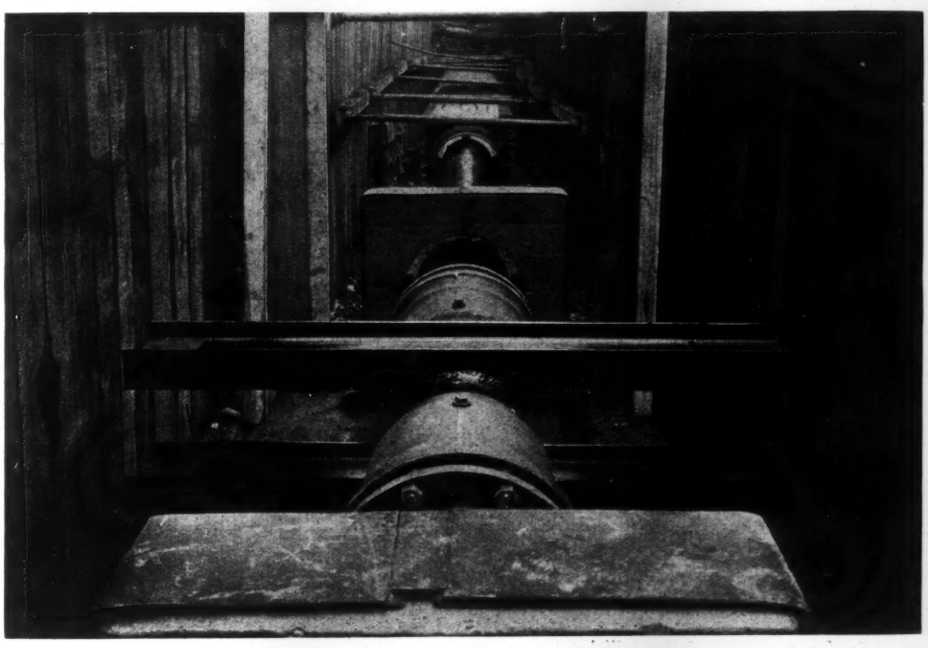
Depth: The depth of the line has been determined largely by the necessity to avoid other existing underground structures. The top of the conduit is within 18 in. of the surface at some points and is as deep as 8 ft. at others.

Cross-Section of Tile Conduit for 16-In. O. D. High Pressure Steam Main

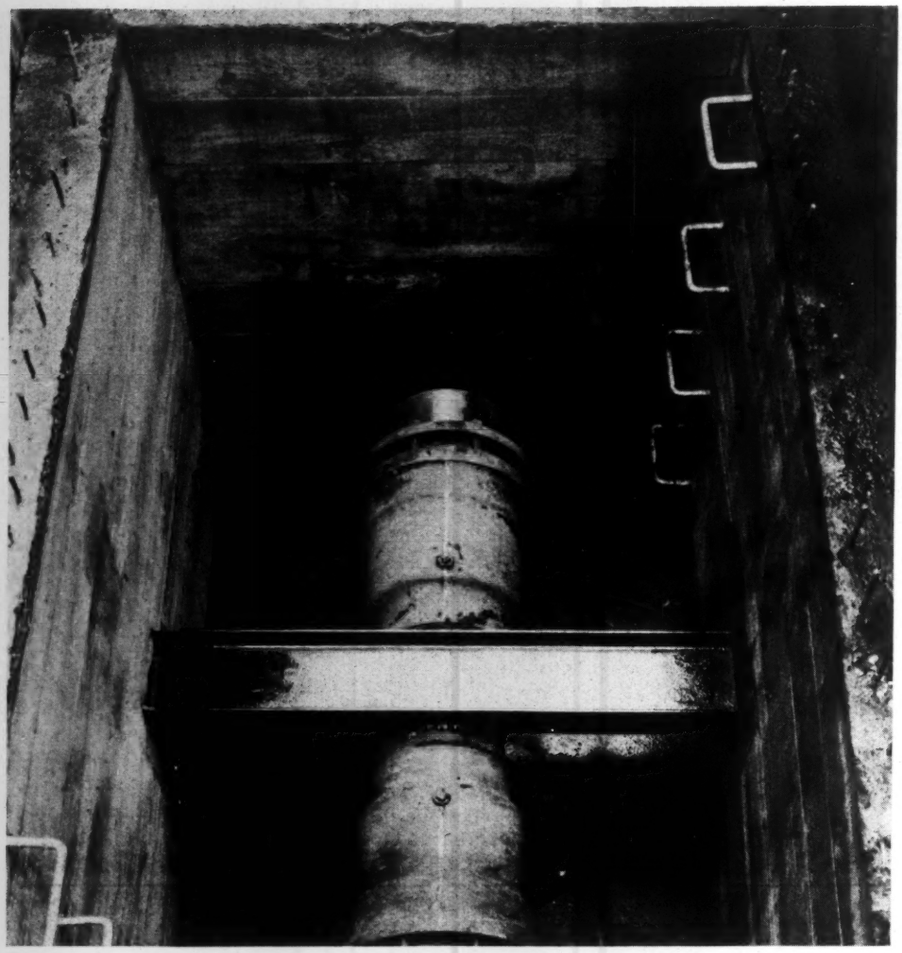


Insulation: The insulation of the line is of particular importance, not only to reduce operating expenses through reduction of radiation losses, but because of the necessity to deliver superheated steam to comply with the terms of the contract. The maximum loss in Btu

As a result of a contract recently signed with a large manufacturing plant, the Indianapolis Power & Light Company has constructed an underground steam line to supply steam at 175 lb. pressure and with 100 F of superheat a mile from its boiler plant. The construction of the line is described in this article.



Manhole Location Before Sidewalls of Manhole Were Poured. Details of Anchor Construction Between Expansion Joints Are Shown, As Is Concrete Terminal Block for Conduit and Expansion Provisions for Conduit



A Completed Manhole Ready for the Roof

per lb. of steam that can be permitted and meet performance requirements is 56.6.

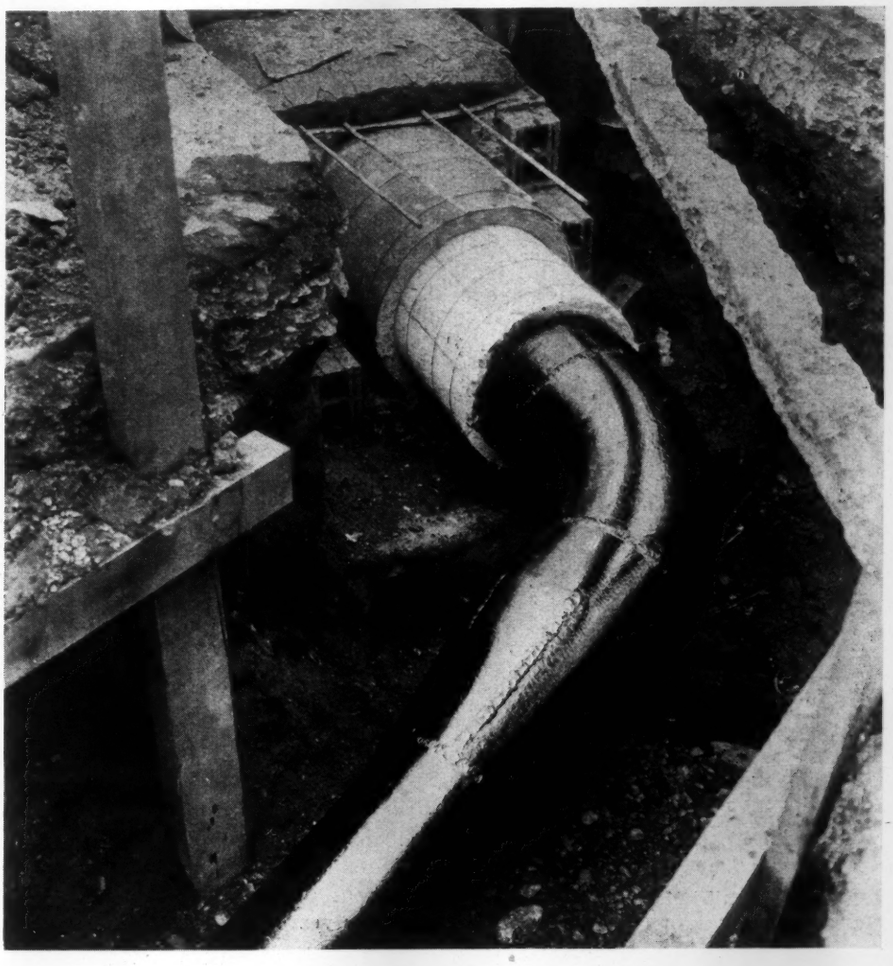
There are three insulating factors that affect the insulation efficiency of an underground steam line. First, the insulating effect of the primary insulation, that is the pipe covering itself. The actual efficiency of the various grades and thickness of pipe covering is fairly well determined and can be accurately predetermined for standard conditions of 70 F in still air. The underground conditions are not standard conditions, and just what the variations from these standards are is an unknown quantity. The air in the conduit surrounding the covering will increase in temperature when the line is placed in service. As this air temperature increases the rate of heat loss will decrease, and would in time become zero, if the conduit itself were a perfect insulator. As the air temperature increases the rate of loss through the conduit increases until a point is reached where the quantity of heat lost through the conduit to the earth is equal to the rate of heat loss through the pipe covering to the surrounding air in the conduit. The heat losses in a horizontal direction are conduction through the pipe and pipe covering, convection through the surrounding air in the conduit, conduction through the solid part of the side walls, convection in three different air spaces in the tile of the side wall, and conduction in the surrounding earth. In the course of this path to freedom the heat experiences surface resistance nine times. The accumulated effect of all of these various insulating factors is unknown at this time and could only be determined by a series of elaborate and expensive test observations. These observations have not been made and are not contemplated.

The second important factor that can seriously affect the insulating efficiency and is not possible of determination is the heat loss by direct conduction through the cast iron supporting rollers, with the losses from the uncovered sections of the pipe that rest on the rollers, and the losses by conduction through the alignment guides and the heavy steel beams that are welded to the pipe and embedded in concrete to anchor the line.

The third unknown factor is the rate of conductivity of all the various kinds of soil with varying amounts of moisture that surround the conduit.

Although the determination of the actual insulating efficiency of the line involved many uncertain factors, the insulation of the pipe covering itself was quite certain and by making conservative assumptions for the unknown factors, it was possible to determine the insulating efficiency so that whatever error there might be would be on the side of safety, and would actually result in a higher rather than a lower efficiency.

Covering Used: The pipe covering used on the 16-in. section of the line was 1½-in. of molded sectional high temperature insulation, fastened with bands of No. 12 copper-clad wire, spaced 6 in. apart. Outside of the high temperature covering a second covering 2 in. thick is placed, so arranged as to stagger the joints with the



Turn in Line, Showing Reducer from 16 In. to 10 In. This Fitting Was Made in the Field

first layer of covering. This in turn is covered with a heavy asphalt roofing jacket, all joints of which are thoroughly sealed.

The 10-in. line has the same general type of covering except the total thickness is reduced from 3½ to 3 in.

All exposed surfaces such as expansion joint bodies and the steel anchor beams are thoroughly insulated. A light-weight steel box formed to the shape of the pipe was placed around every roller support and packed with loose rock wool to insulate these usually exposed points.

Conduit: The conduit with the gravel sub-base and sub-base drainage tile is shown in the accompanying detail. As the construction was done in the middle of winter, all concrete was of the quick-setting type and precautions were taken to prevent freezing.

Pipe: The 16-in. section of the line (2,573 ft. long) is of beveled end pipe, 20-ft. random lengths weighing 77.5 lb. per ft. The 10-in. section of the line (2,600 ft. long) weighs 40.48 lb. per ft. All rolling pipe welds were made by electric welding, and all stationary welds were made with gas welding.

Expansion: In the length of the line (5,173 ft.) the amount of elongation of the pipe totals 23 ft. This elongation is provided for by thirty-nine cast steel body, sleeve-guided, packed expansion joints. These expansion joints are placed two in a man-hole separated by a 20-in. spacer piece. The manholes are spaced about 300 ft. apart, with an anchor about midway between manholes and one in each manhole.

The anchors consist of two 12-in. 50-lb. I-beams, one each welded to the top and bottom of the pipe, and extending through the conduit proper, or manhole walls, 18 in. into solid concrete anchor blocks. At all turns in the line anchors of similar type are located from 15 to 20 ft. on each side of the turning fitting, leaving the fitting itself free to take the expansion from this short length of pipe.

Two cast iron alignment guides, thoroughly secured in concrete, and spaced about 15 ft. apart, are located within 20 ft. of each expansion joint to insure straight line movement of the slip in the expansion joint. All expansion joints are equipped with three lubricating fittings spaced around the packing gland so located as to permit lubrication of packing while in service.

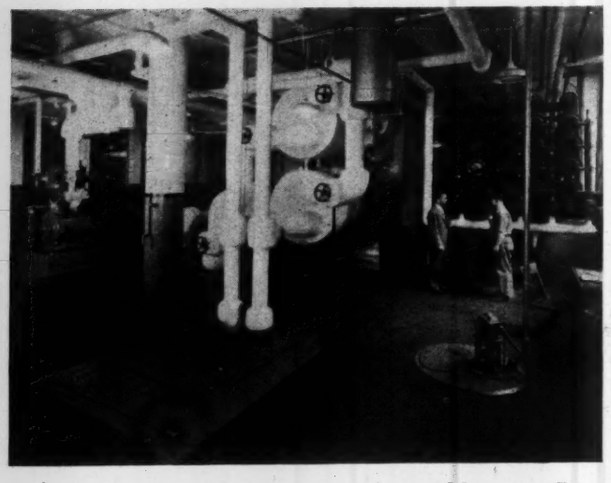
Line Will Act as Surge Tank

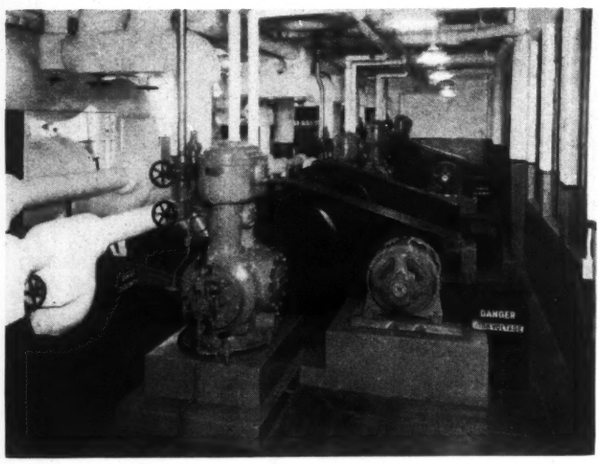
The total volume of the line will be about 2,000 cu. ft. and it will contain under normal pressure conditions about 2,400 lb. of steam. The line itself will act as an accumulator or surge tank and will smooth out any sudden fluctuation in load.

The ten low points in the line are trapped and discharged through a flash tank and cooling pipe into the sewer. These traps are located in manholes adjacent to, but separated from, the conduit or expansion joint manholes.

Refrigerating System

Cools Air and Water
Condenses Alcohol
Freezes Waxes
Makes Ice
Etc. » »





ABOVE—MACHINE ROOM SHOWING ONE COMPRESSOR AND BRINE COOLERS. RIGHT—MACHINE ROOM SHOWING FOUR COMPRESSORS

By Terry Mitchell*

THE refrigerating system installed in the 9-story Philadelphia plant of Sharp & Dohme, manufacturers of pharmaceutical and biological products, is remarkable in many ways. It is one of the largest automatic plants; it cools air for the comfort of occupants of the building, condenses alcohol, freezes waxes, cools drinking water, hardens gelatin, makes ice, cools storage rooms, chills elixirs, etc.

The machines consist of two 8 x 8's, a 9 x 9 and a 10 x 10, driven by V-belts and equipped with mechanical oilers in addition to a force-feed lubricating system. The motors, of 50, 75 and 100 hp., respectively, are of the full voltage starting type operating on 2,300-volt current.

The load is divided between two sets of brine coolers, in each of which one shell is a spare; the high temperature brine is held at 10 F, representing about 90 tons refrigeration; and the low temperature system, totalling some 12 tons, is carried between —16 and —10 F. Any compressor can work on either the high or low temperature load, as two suction headers are run above the line of machines; a third header is for pump-out purposes.

There are two thermostats in the high temperature brine system, one being set for a range of 14 to 10 F and the other for a range of 12 to 8 F. If the load becomes too great for one compressor, a second machine will automatically start; this saves repeated starting of both the larger compressors. On the switchboard, a high pressure cut-out is set to shut down the plant if the head pressure exceeds 220 lb., and brine pressure failure switches are hooked in with each of the circulating systems.

All boxes and cooling units throughout the plant are equipped with thermometers in the brine feed and in the brine return; eight of the refrigerators are supplied with recording thermometers. Automatic regulation of the brine flowing into the various boxes is provided; each regulator has a three-valve by-pass and a brine strainer. On the boxes to be held at extremely low temperatures, air-operated controls are used.

The biological general stores room contains an average of a million dollars worth of medicines and serums and is held at 35 F by a unit air cooler; built into the wall at one corner is the smallpox vaccine refrigerator, which is kept at 10 F.

In the soft gelatin department, there is installed an air cooling unit connected to the high temperature system, to maintain a temperature of 35 F. Connected to this room is a small blower which discharges air over a wheel on which there is a series of molds for making soft capsules. The molds dip into liquid hot gelatin; cold air is blown on them so that they will be firm after one revolution of the wheel.

On the 5th floor is a large water cooler, with two 65-g.p.m. pumps, which circulate the cold water to the insulin department on the 6th floor. Alongside this cooler is another water cooler having a capacity of 18 tons, together with 60-g.p.m. water pumps; these circulate water to an air cooling unit on the 7th floor which supplies air to the biological filling department. Both coolers are connected to the high temperature brine.

On the 5th floor, there are also two water cooling tanks which supply cold water to the unit air conditioners in the acidophilus department on the 7th floor. On the same floor a glass-enclosed room used for preparing the mixture is cooled by a conditioning unit. Without dried air, the mixtures absorb so much moisture, due to the

*Frick Company, Inc., Waynesboro, Pa.

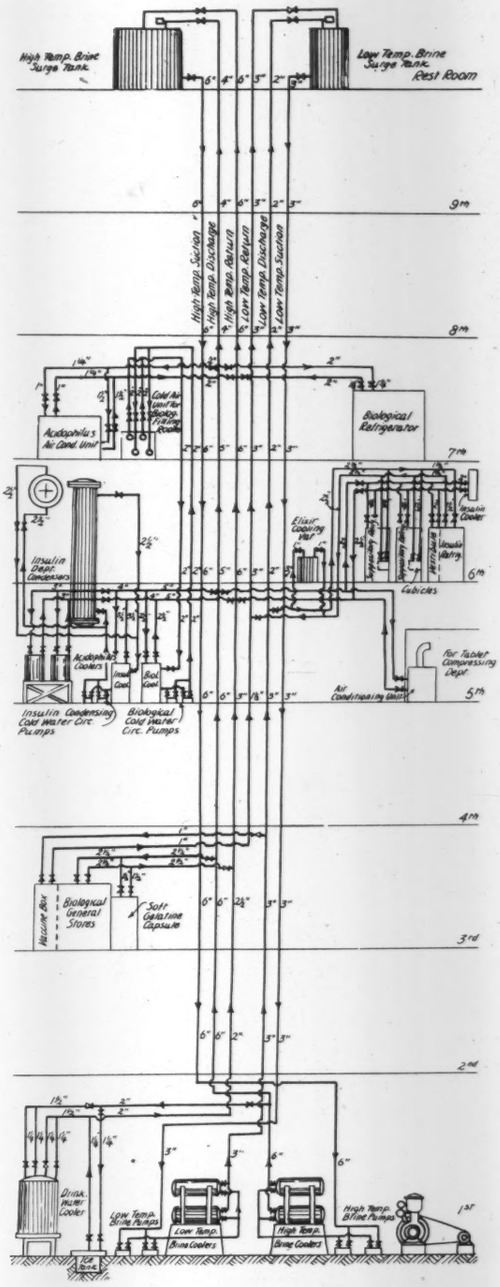


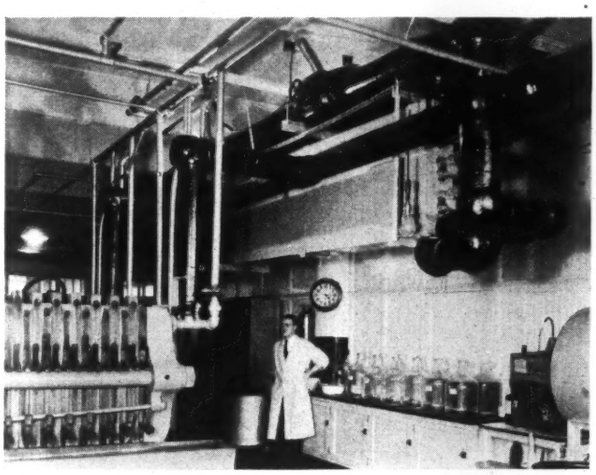
DIAGRAM SHOWING THE MANY DIFFERENT SERVICES AND ARRANGEMENT OF PIPING AT SHARP & DOHME PLANT

salts contained in them, that they cannot be molded into the tablets.

Insulin is made by extracting the active principle from certain glands by means of acidulated alcohol. Some 4½ tons of refrigeration are required for cooling the insulin itself, and about 25 tons is required in the condenser which cools the alcohol fumes. A low temperature room 20 ft. by 13 ft. by 11½ ft. is used for the storage of the glands for insulin and endocrine products. This box is held at —4 F by brine coils. The finished insulin solution is stored in bottles in the vestibule of the gland refrigerator.

Suppositories are hardened in bronze molds, the molds being quickly chilled by placing them in a miniature cold storage box or cubicle; these cubicles measure 16 or 18 in. each way and are fitted with little wall coils and two hollow blocks of iron with brine circulating inside. The cubicles are supplied with low temperature brine; the storage rooms are held at 35 F by unit coolers using high temperature brine.

On the 6th floor is also a cylindrical tank, inside of which is a square metal vat or pan submerged in brine; the brine is cooled by 1¼-in. coils on the low temperature system. The vat is used for precipitation of inert substances from preparations manufactured in the elixir department, where cough syrups, flavoring extracts and emulsions are made. On the 7th floor are the coolers



ABOVE—INSULIN COOLER. RIGHT—TABLET COMPRESSING DEPARTMENT

for acidophilus bacteria solutions which when solidified into blocks are coated with chocolate. The enrober is furnished with cooled and dried air from an air conditioner connected to the high temperature brine system.

Another air cooler on this floor is connected to a series of glass-enclosed rooms, many of them very small, in which biological solutions are sealed in glass tubes. Before refrigerated air was supplied these enclosures, the heat from the bunsen burners was so objectionable that work often had to be suspended.

One of the items which must be considered in selecting the heating boiler is the capacity required so that the system will have a satisfactory warming-up period from a cold or partially cold condition. How this capacity is determined is told here; the tables simplify solution of the problem.

SELECTING *the right size* Heating Boiler

By Sabin Crocker*

THE analysis given in the February issue dealt with computation of boiler load existing after the boiler, the water content of the boiler and piping, and the metal in the piping and radiators all have attained their operating temperature, and the air temperature of the building has been raised to the design figure.

Item 4—Satisfactory Warming-Up Period

The boiler must have considerable excess capacity in order to attain this normal operating condition; various empirical rules have been proposed for determining what boiler capacity should be provided for warming up different heating systems. According to the *A. S. H. V. E. Guide* 1931 the excess capacity based on the summation of items *1, 2* and *3* should not be less than the following:

TABLE 6—WARMING UP ALLOWANCE

Load representing summation of Items 1, 2 *and* 3

LOAD IN BTU PER HR.	EQUIVALENT SQ. FT. 150 BTU RADIATION (WATER)	EQUIVALENT SQ. FT. 240 BTU RADIATION (STEAM)	PERCENTAGE CAPACITY TO ADD FOR WARMING UP
Up to 100,000	Up to 670	Up to 420	65
100,000 to 200,000	670 to 1,340	420 to 840	60
200,000 to 600,000	1,340 to 4,000	840 to 2,500	55
600,000 to 1,200,000	4,000 to 8,000	2,500 to 5,000	50
1,200,000 to 1,800,000	8,000 to 12,000	5,000 to 7,500	45
Above 1,800,000	Above 12,000	Above 7,500	40

*Engineer, The Detroit Edison Company, Detroit, Mich.

The total Btu loads obtained by adding the above percentages represent the rate of heat absorption required of the boiler water. Stated differently, this amount of heat must be transferred per hour through the boiler surface from the fire to the water during the warming-up period. For satisfactory operation the boiler and fuel burning equipment must be large enough to carry this load without undue forcing of the fire and with a satisfactory stack temperature, or in other words, with reasonable efficiency. Ability to carry the load hinges principally on grate area, or burner capacity with liquid or gaseous fuel, and on boiler heating surface. Adequate furnace volume for proper combustion is a necessary requisite which may be assumed as provided for in good boiler design. Reasonable fuel burning and heat transfer rates are discussed in subsequent paragraphs with relation to boiler efficiency. The percentage allowances given in Table 6 represent the minimum recommended for good design, and larger allowances may be used to advantage in many cases, especially with expensive fuel where a high efficiency is desirable. A practice frequently followed with small boilers is to provide for covered piping loss and warming-up allowance by selecting a boiler for which the manufacturer's rated output is twice the equivalent load of standing radiation plus bare piping and water heating.

Steam boilers selected according to Table 6 should be able to bring a direct cast iron radiator system with its piping up to operating temperature within one hour. Systems consisting mainly of unit heaters or other concentrated load can be brought to operating temperature in a shorter time.

Much confusion has arisen through lack of agreement between catalog ratings of different boiler manu-

facturers. Such ratings differ in the allowances included for pipe losses and warming up. In some instances the ratings denote the actual sq. ft. of steam or water radiation which a boiler can carry, in addition to piping tax, etc., and therefore require no additional percentage for pipe losses and warming-up. Other manufacturers rate their products with reference to heat absorption in the boiler expressed in sq. ft. of radiation, which, of course, requires that pipe losses and warming-up be added to heat emission of the radiation in selecting a boiler. Another system of rating requires that pipe losses be lumped with standing radiation, but provides for warming-up by the way ratings are given. Some manufacturers have changed from one system to another when issuing a new catalog.

Many mistakes have been made in selecting boilers and a great deal of uncertainty regarding methods of selection has existed. This situation has led to the drafting of several codes specifying how boiler loads shall be computed and what grate area, heating surface, furnace volume and the like shall be considered as adequate for a given load. The requirements of some of these codes are discussed in later paragraphs.

A Good General Rule

A good general rule for sizing steam heating boilers to meet the maximum load during the warming-up period and provide satisfactory efficiency under normal operation is to provide one sq. ft. of boiler heating surface for each 14 sq. ft. of equivalent 240-Btu radiation represented by standing radiation, piping loss and domestic water heating. This is equivalent to letting 10 sq. ft. of boiler heating surface represent one boiler horsepower, which is evident from the following equation in which x is the sq. ft. of 240-Btu radiation per sq. ft. of boiler heating surface:

$$\text{One boiler horsepower} = 34.5 \times 970.4 = x \times 10 \times 240$$
$$x = 13.95, \text{ or approximately } 14$$

where 34.5 is lb. of steam per hr. evaporated from and at 212 F and 970.4 is the latent heat of evaporation of water at atmospheric pressure in Btu per lb. In this case it is assumed that pick up will be obtained by operating the boiler at a rate exceeding 100 per cent referred to a boiler horsepower basis.

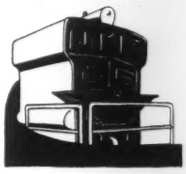
With boilers in small industrial jobs and residences, it is advisable to reduce the 14-sq. ft. figure to about 10 sq. ft. of radiation per sq. ft. of boiler heating surface, especially where full automatic (intermittent) oil firing is used. This tends to keep the stack temperature down with a bettering of efficiency in the case of such oil burning installations where the burner is either going with maximum flame or not at all. According to Harding and Willard,[3] "With house heating boilers either for water or steam, it is probably not desirable in the interests of economy to require a heat absorption exceeding 1800 to 2400 Btu per sq. ft. per hr., depending upon size of boiler. As each sq. ft. of radiating surface requires about 240 Btu per hr. for steam, and 150 Btu for hot water, one sq. ft. of heating surface would, under these conditions, supply from 7½ to 10 sq. ft. of radiating surface for steam, and 12 to 16 sq. ft. for hot water. These values are for average operating conditions and may be exceeded under maximum conditions of operation by 100 per cent."

[3] Mechanical Equipment of Buildings, Vol. I, Second Edition, p. 90.

The Warming-up Problem Explained

It seems worth-while at this point to take up in some detail the various phases of the warming-up problem. If heating systems were kept warm at all times from fall to spring by a type of steady firing which adjusted itself perfectly to the weather, there would be no occasion for a warming-up allowance. This condition is seldom, if ever, realized in building heating for a number of reasons, some of which follow. (1) Heat is not required on mild days in spring and fall, but must be brought up quickly on short notice due to a change in weather—say on a chilly morning following the end of a mild period after the building has had a chance to cool over night. (2) With hand firing the system and building may cool before the fire is replenished and need to be brought up to temperature again quickly. (3) With automatic firing the building may be allowed to cool 10 to 20 F at night below the day-time temperature and then be brought up again quickly in the morning. (4) Buildings such as churches and auditoriums which are heated on occasion must be brought up to the desired temperature within a reasonable length of time.

A further reason for some warming-up allowance in any system is the extra load represented by a fall in air temperature inside the building. If heat is cut off for any reason and the air temperature in the building falls below the design temperature, an added load is thrown on the heating system due to the increased heat emission in cooler air. According to Table 2,[4] a fall in room temperature of 10 F increases the heat emission about 9 per cent, so that a fall in room temperature of 10 F puts a 9 per cent extra starting tax on the system.



What Is "Satisfactory" Warming-up Time?

When occasion warrants, it is possible to substitute rational engineering methods in place of empirical rules and compute the size boiler required to produce a desired result. Some assumption regarding a satisfactory time to bring the entire system to the operating temperature is required as a basis. What constitutes a satisfactory time varies with different applications, but probably one hour is about the average time to expect for a steam system from a "stone cold" start, represented for instance by room temperature and boiler temperature both at 50 F with the fire out. The one hour would not include time required for kindling a coal fire or for bringing the room temperature up to, say, 70 F after raising the system to operating temperature.

Computing the Time Required

Computation of the total time required involves the following steps in the case of a steam system:

(*a*) Assume what seems to be the right size boiler using one of the empirical rules, say that of the *A. S. H. V. E.*

(*b*) Compute the time required to bring the boiler and its water content from 50-F up to the operating temperature. This involves computing the total amount of sensible heat needed to raise the temperature of boiler metal and water content, which amount then is divided by the rate of heat absorption through

[4] See Heating, Piping and Air Conditioning, February, 1932, p. 104.

the boiler surface to obtain the length of time required. In case the boiler is well insulated, heat loss from the boiler exterior can be neglected, otherwise some allowance should be made for this loss.

(*c*) Compute the weight of metal in covered piping. This part of the system will get warm next after the boiler and its time interval should be computed as a separate item, assuming that the full output of the boiler will be available for this purpose during the time interval involved. Radiation loss from this piping will be small, but can be taken into account by assuming that the normal covered pipe loss of 50-F air temperature exists during this period, which compensates in part for heat absorbed in raising the temperature of the covering.

(*d*) Compute the weight of metal in bare piping and radiators, and from this the amount of heat required to bring them from 50-F to operating temperature. The full output of the boiler will not be available for this purpose since the covered pipe tax must be carried as well as picking up the heat emission load of radiators and bare piping as they warm up in rooms at temperature lower than normal. All these factors can be taken into account by an approximate heat balance method, or by the use of formulas or curves relating the factors. Both methods are explained in later paragraphs.

Item *a* above already has been explained. Item *b* can be computed from data obtained from the boiler manufacturer, or in case this is not convenient the typical values of Table 7 can be used as approximations for the types of boilers indicated.

TABLE 7—TYPICAL WEIGHTS OF BOILERS AND WATER CONTENT IN LB. PER SQUARE FOOT OF HEATING SURFACE [a]

Boiler Heating Surface Sq. Ft.	Metal Weight		Water Weight			
			Steam Boiler		Water Boiler	
	Cast Iron Sectional	Steel Portable Fire-box Type	Cast Iron Sectional	Steel Portable Fire-box Type	Cast Iron Sectional	Steel Portable Fire-box Type
15–25	55–65	40–45	8	.....	11	.....
25–50	45–55	35–40	7–8	12–14	10–11	16–19
50–100	40–50	25–35	6–8	12–14	9–11	14–19
100–500	35–40	15–25	6–7	9–14	9–11	14–19
500–1000	30–35	12–22	6	9–10	10	13–14
1000–3000	30–35	10–17	.....	7–10	.....	10–14

[a] The specific heats in Btu per lb. per F are as follows: water = 1.00; cast iron = 0.13; steel = 0.117.

Items *c* and *d* can be computed from Tables 8, 9, 10 and 11 giving the weights of pipe, screwed and flanged fittings and radiators respectively.

Weight of Pipe and Fittings

Computing the weight of pipe in a given heating system is a comparatively easy job, while computing the weight of the variety and size of fittings used is somewhat tedious. For this reason it may be convenient to express the weight of fittings as a percentage of the pipe weight. Analysis of typical steam and water jobs containing a mixture of flanged and screwed fittings indicates that the fittings and valves weigh approximately half as much as the pipe. Where screwed fittings are used exclusively, their weight may run 20 to 25 per cent that of the pipe, while with flanged fittings the weight may run to 75 per cent that of the pipe. In flanged boiler outlet headers and the like, the weight of fittings may be several times the weight of pipe. Where direct cast iron radiation is used, the combined weight of fittings, pipe and valves usually will be from 2 to 3 lb. for each sq. ft. of standing radiation, the higher value applying to water systems or where flanged fittings predominate.

With welded jobs the approximate weight of all welded fittings can be obtained by counting their center line measurements as so much pipe, since welded fittings commonly are of the same thickness as the pipe with which they are used. Some additional allowance is required for valves and such flanges and flanged fittings as are used. This allowance probably will not run more than 5 to 10 per cent of the weight of pipe and welded fittings.

Example of Method for Computing Warming-up Period:

Two examples will be given of the method just de-

TABLE 8—WEIGHT PER LINEAL FOOT OF STANDARD WEIGHT AND O. D. STEEL AND WROUGHT IRON PIPE WITH PLAIN ENDS [a]

Nominal Size, In.	Thickness, In.	Metal Weight per Ft., Lb.	Water Weight per Ft., Lb.	Nominal Size, In.	Thickness, In.	Metal Weight per Ft., Lb.	Water Weight per Ft., Lb.
⅛	0.109	0.850	0.13	5	0.258	14.617	8.67
¾	0.113	1.130	0.23	6	0.280	18.974	12.51
1	0.133	1.678	0.37	8	0.322	28.554	21.68
1¼	0.140	2.272	0.65	10	0.365	40.483	34.19
1½	0.145	2.717	0.88	12	0.375	49.562	48.94
2	0.154	3.652	1.45	14 O.D.	0.375	54.568	59.78
2½	0.203	5.793	2.07	16 O.D.	0.375	62.579	79.18
3	0.216	7.575	3.19	18 O.D.	0.409	76.840	100.5
3½	0.226	9.109	4.29	20 O.D.	0.409	85.577	124.8
4	0.237	10.79	5.50	24 O.D.	0.4375	110.10	181.0

[a] The specific heats in Btu per lb. per F are as follows: steel = 0.117; wrought iron = 0.114; cast iron = 0.13; water = 1.00. Density of water is 62.4 lb. per cu. ft.
The weight of couplings, flanges, fittings and valves runs about 50% that of the pipe metal for average jobs with a mixture of flanged and screwed joints. In welded jobs, count welding fittings as pipe and add about 10% for the weight of valves, flanges and flanged fittings.

TABLE 9—APPROXIMATE WEIGHT IN LB. OF 125-LB. STANDARD CAST IRON SCREWED FITTINGS

Nominal Pipe Size, In.	90° Ell	45° Ell	Tee	Cross	Y Bend	Union[a]	Reducer 1 Size	Bushing, 1 Size	Cap	Plug, Square Head Regular	Plug, Square Head Solid
¼	0.15	0.15	0.25	0.40	.....	0.20	.....	0.03	.....	0.03	.....
⅜	0.25	0.20	0.35	0.40	0.60	0.30	.....	0.04	.....	0.06	.....
½	0.40	0.35	0.55	0.70	0.60	0.40	.....	0.06	.....	0.08	0.10
¾	0.65	0.55	0.85	1.00	1.00	0.60	.....	0.12	.....	0.15	0.20
1	1.00	0.85	1.50	1.75	1.75	1.00	.....	0.20	.....	0.20	0.30
1¼	1.50	1.25	2.00	2.50	2.50	1.25	1.25	0.35	1.00	0.35	0.55
1½	2.00	2.00	2.75	3.50	3.50	1.75	1.75	0.45	1.50	0.50	0.75
2	3.00	2.75	4.25	5.25	5.25	2.75	2.25	0.70	2.00	0.80	1.25
2½	4.75	4.75	6.50	8.00	8.50	4.50	3.00	1.25	2.75	1.25	2.00
3	7.25	6.50	9.50	11.00	12.00	6.00	4.75	1.75	4.50	2.00	3.00
3½	9.50	8.50	14.00	16.00	17.00	9.75	6.25	2.50	5.75	2.75	4.00
4	12.00	11.00	18.00	21.00	24.00	13.00	8.00	2.75	6.25	3.25	5.50
5	22.00	18.00	28.00	32.00	41.00	26.00	13.00	4.25	11.00	5.25	10.00
6	30.00	27.00	40.00	45.00	57.00	40.00	19.00	7.25	16.00	7.50	14.00
8	62.00	44.00	79.00	88.00	121.0	50.0	31.00	11.00	31.00	16.00	27.00
10	116.0	88.00	154.0	170.0	252.0	80.0	56.00	21.00	50.00	26.00	51.00
12	178.0	126.00	230.0	271.0	384.0	120.0	83.00	31.00	80.00	41.00	75.00

[a] Std. weight malleable iron ground joint type up to and including 4-inch; cast iron flanged union with bolts 5 in. and larger.

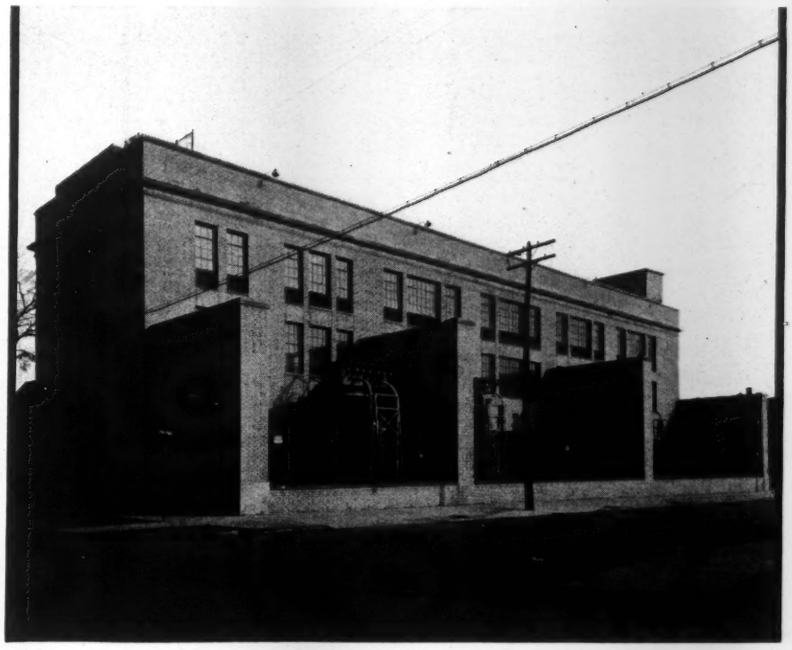


FIG. 5 — EXTERIOR OF PULFORD SUBSTATION OF THE DETROIT EDISON COMPANY

scribed for computing the time required for warming up a heating system; they deal with practically identical buildings constructed the same year, the first having a one-pipe steam system and the second a two-pipe gravity hot water job. The steam job is in the Pulford substation, shown in Fig. 5. Decision to install a steam system in one building and a hot water in the other was made on the grounds of obtaining comparable data on the first cost and operating performance in two similar substations, and in order to compare erection interference between electrical conduit and one-and two-pipe heating systems.

In both buildings a portion of the space used as switchboard gallery, toilet, etc. is heated continuously to 70 F, while the major portion of the space, which houses switch compartments, regulators, bus structure and the like, is heated to 50 F when occasion requires. The original intention was not to heat all of the space now provided with 50-F radiation, since portions are patrolled only occasionally and extensive maintenance work was not anticipated there. The first winter's operation demonstrated, however, that objectionable atmospheric condensation took place on the walls, ceilings and equipment in the unheated portions during rainy spells following cold snaps. This condensation was due to the interior building structure being at a temperature below the dew point of the damp outdoor air penetrating the rooms at these times. It was found necessary, therefore, to install radiation in these rooms which could be turned on when occasion required to forestall this trouble. Consequently the maximum load which the boilers must carry at times is 1/3 to ½ greater than might be considered good design. On the other hand, the fact that portions of the buildings are heated only occasionally is some justification for using boilers which are under-sized with respect to the occasional peak load. In the writer's opinion the load on these boilers, all circumstances considered and after observing their performance for several years, is fully at the upper limit beyond which it would not be advisable to go.

The first example is for the one-pipe steam system of Pulford substation, which follows closely the outline given above. The second example is for the two-pipe gravity hot water system of Garfield substation. The method used in computing the warming-up period for a water system differs from the steam system method in that the temperature of the whole mass of metal and water must be raised simultaneously instead of in steps. The computed period and rate of water temperature rise for Garfield substation has been checked by actual test of the system from a cold start.

TABLE 10—APPROXIMATE WEIGHT IN LB. OF 125-LB. STANDARD CAST IRON FLANGED FITTINGS

NOMINAL SIZE IN.	90° ELLS	45° ELLS	L.R. ELLS	BASE ELLS	TEES	CROSSES	LATERALS	SCD. FLGS.	BLIND FLGS.	FLGD. UNIONS
½	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
¾	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	.....	.....	.....	.....	.....	.....	.....	2	2	3
1¼	.....	.....	.....	.....	.....	.....	.....	3	3	4
1½	.....	.....	.....	.....	.....	.....	.....	4	4	5
2	18	15	.....	.....	26	34	.....	5	5	6
2½	22	20	.....	.....	34	43	.....	7	7	9
3	30	27	.....	.....	45	58	.....	8½	9	12
3½	37	33	.....	.....	55	74	.....	11	13	15
4	41	38	60	70	67	89	90	12	17	17
4½	46	43	70	.....	75	100	100	13	18	21
5	63	53	80	100	90	121	120	15	21	25
6	75	68	100	125	115	152	140	18	27	34
7	100	90	150	150	150	200	190	25	37	48
8	120	100	185	190	170	236	230	32	45	57
9	150	130	225	230	220	305	310	35	56	65
10	205	160	275	270	285	400	325	44	67	84
12	285	230	410	370	430	570	600	65	99	116
14	390	300	600	540	550	750	750	95	133	.....
15	440	330	675	.....	660	800	925	100	150	.....
16	525	400	875	700	760	1000	1000	105	175	.....
18	.....	.....	.....	.....	.....	.....	.....	125	215	.....
20	.....	.....	.....	.....	.....	.....	.....	175	281	.....
22	.....	.....	.....	.....	.....	.....	.....	195	347	.....
24	.....	.....	.....	.....	.....	.....	.....	230	422	.....

TABLE 11—APPROXIMATE WEIGHTS IN LB. PER SQUARE FOOT OF RATED SURFACE FOR CAST IRON RADIATORS [a]

TYPE RADIATOR	CAST IRON	WATER
Column	7.50	1.00
Tube	5.50	1.00
Light weight	4.125	0.75
Wall	7.00	1.40

[a] The specific heats in Btu per lb. per F are as follows: water = 1.00; cast iron = 0.13.

Computation of Warming-Up Period for Pulford Substation One-Pipe Steam System

Boiler Data

Rectangular cast iron boiler, 274 sq. ft. of heating surface.

Manufacturer's recommended load, 3800 to 4450 sq. ft. of nominal steam radiation based on sum of Items *1, 2* and *3*, (See "box" to right).

Desirable load representing sum of Items *1, 2* and *3* based on 14 sq. ft. of nominal radiation per sq. ft. of boiler heating surface = 274 × 14 = 3840 sq. ft.

Equivalent nominal radiation load representing sum of Items *1, 2* and *3* = 5932 sq. ft. (See explanation in text).

Rate of heat transfer in Btu per sq. ft. per hr. of boiler heating surface to pick up connected load plus a 25% extra starting allowance (about the most obtainable with this overload) = (5932 × 240 × 1.25) ÷ 274 = 1,780,000 ÷ 274 = 6,500.

Weight of cast iron in boiler = 9,310 lb.

Estimated weight of water content (from Table 7) = 274 × 6.5 = 1771 lb.

Heat required to warm boiler from 50 to 215 F

Boiler metal	= 9,310 × 0.13 × 165 =	200,000 Btu
Water content	= 1,771 × 1.00 × 165 =	292,000
		492,000

Time required to warm boiler from 50 to 215 F

(492,000 ÷ 1,780,000) 60 = 16.6 minutes.

Weight of covered piping

Covered pipe in boiler room	= 783 lb.	
Covered pipe in basement	= 1,670	
Total steel	2,453	
Covered fittings in boiler room	= 1,351 lb.	
Covered fittings in basement	= 525	
Total cast iron	1,876	

Heat required to warm covered piping from 50 to 215 F

Steel pipe	= 2453 × 0.117 × 165 =	47,500 Btu
C. I. fittings	= 1876 × 0.13 × 165 =	40,200
		87,700

Time required to warm covered piping from 50 to 215 F

(87,700 ÷ 1,780,000) 60 = 2.95 (say 3 minutes)

Weight of bare piping and radiators (neglecting 2 small unit heaters)

Bare steel pipe	= 3600 lb.	
Bare fittings		= 1,140 lb.
Wall radiation	= 450 × 7.0	= 3,150
Column radiation	= 3,367 × 7.5	= 25,250
Total cast iron		29,540

Heat required to warm bare pipe and radiators from 50 to 215 F.

Steel pipe	= 3,600 × 0.117 × 165	= 69,300 Btu
Cast iron	= 29,540 × 0.13 × 165	= 635,000
Total		704,300

Total heat emission from system—5932 sq. ft. 240-Btu radiation including radiators and bare and covered pipe

5932 × 240	= 1,420,000 Btu per hr.
Add for 70 F radiation being in 50 F air temperature	= 51,500
Total	1,471,500

Average emission while radiation and bare piping is warming up (Approximately 50 per cent of above total)

1,471,500 ÷ 2 = 735,750 Btu per hr.

735,750 ÷ 60 = 12,262 Btu per min.

Time required in minutes to heat radiation and pipe from 50 to 215 F

Let x = number of minutes required

Among the items affecting the selection of the right size heating boiler are:

(1) Amount of connected (standing) radiation.
(2) Heat loss from bare and covered piping in supply and returns.
(3) Domestic hot water requirements.
(4) Satisfactory warming-up period from a cold or partially cold condition of the entire system.
(5) Efficiency with hard or soft coal, gas- or oil-firing as the case may be.
(6) Grate area with hand-fired coal, or fuel burning rate with stokers, oil or gas.
(7) Combustion space in the furnace.
(8) Type of heat liberation, whether continuous or intermittent or a combination of both.

The first three items were discussed in detail in the February issue; the fourth is the subject of the present contribution. Next month, Mr. Crocker will consider Items 5, 6, 7, and 8. These three articles are a thorough treatise on this very important subject.

$$12{,}262\,x + 704{,}300 = (1{,}780{,}000 \div 60)\,x$$

$$x = 40.4 \text{ minutes.}$$

Total time to warm system

Boiler	16.6 minutes
Covered piping	3.0
Radiators and bare piping	40.4
Total	60.0

Computation of Warming Up Period for Garfield Substation Two-Pipe Gravity Hot Water System

Boiler data

Rectangular cast iron boiler, 294 sq. ft. of heating surface.

Manufacturer's recommended load, 6,600 to 7,120 sq. ft. of 150-Btu hot water radiation based on sum of Items *1, 2* and *3*.

Desirable load representing sum of Items *1, 2* and *3* based on 22.4 sq. ft. of nominal 150-Btu radiation per sq. ft. of boiler heating surface = 294 × 22.4 = 6,330.

Equivalent nominal radiation (150 Btu) load representing sums of Items *1, 2* and *3* = 9,700 sq. ft.

Assume a maximum heat transfer rate of 6,500 Btu per hr. per sq. ft. of boiler heating surface, which gives a total heat transfer of 294 × 6,500 = 1,910,000 Btu per hr.

Heat required to raise boiler temperature from 50 to 180 F

Cast iron in boiler weighs 10,000 lb.

Water content of boiler weighs 294 × 10 = 2,940 lb. (from Table 7)

10,000 × 0.13 × 130	=	169,000 Btu
2,940 × 1.00 × 130	=	381,000
		550,000

Heat required to raise metal and water contents of piping and radiators to an average temperature of 170 F from 50 F

Weight of steel pipe	= 15,541 lb.	
Weight of cast iron fittings	= 7,721	
Weight of cast iron radiators	= 37,550	
Weight of water content of piping	= 8,080	
Weight of water content of radiators	= 5,218	
15,541 × 0.117 × 120	=	218,000 Btu
7,721 × 0.13 × 120	=	121,000
37,550 × 0.13 × 120	=	586,000
8,080 × 1.00 × 120	=	970,000
5,218 × 1.00 × 120	=	628,000
		2,423,000

Summation of heat required to raise metal and water content of system from 50 F to temperatures indicated

Boiler	= 550,000 Btu
Piping and radiators	= 2,423,000
	2,973,000

Total heat emission from system with average water temperature of 170 F

Sum of Items *1, 2* and *3* = 9,700 sq. ft. of 150-Btu radiation

9,700 × 150 = 1,455,000 Btu

Add 10% for building air temperature being 10 F below normal = 145,500

1,600,500

Average heat emission from system during warming up period

1,600,500 ÷ 2 = 800,250 Btu per hr.

Time required in hours to bring system from 50 to 170 F average

Let x = number of hours required

$2{,}973{,}000 + 800{,}250\,x = 1{,}910{,}000\,x$

$x = 2.68$ hr.

= 2 hr. and 41 min.

Temperature rise per hr. after average water temperature has reached 170 F

Heat output of boiler	= 1,910,000 Btu per hr.
Less emission of system	= 1,600,500
Balance available for raising water temperature	= 309,500

Heat to raise system 1 F =

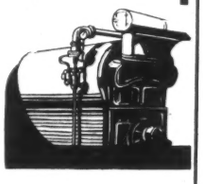
Boiler	550,000 ÷ (180-50)	=	4,230 Btu
Radiation & piping	2,423,000 ÷ (170-50)	=	20,200
			24,430

309,500 ÷ 24,430 = 12.7 F per hr.

Solution by Formula and Chart

A method of computing the warming-up period for steam and hot water heating systems was presented by Ralph C. Taggart in the *A. S. H. V. E. Transactions* for 1913. While Mr. Taggart's formulas yield a solution of the problem, they are rather involved and probably more difficult to solve than the direct heat balance method used in the foregoing examples. Fortunately, L. A. Harding has prepared two useful charts based on Mr. Taggart's formulas. These charts were included in the report of the *A. S. H. V. E. Continuing Committee on Codes for Testing and Rating Steam Heating Solid Fuel Boilers,* presented at the annual meeting of that Society in January, 1930, and are reproduced here (by permission) in Fig. 6.

The *heating-up factor, F,* represents unity plus the decimal fraction of the connected load (sum of Items *1, 2* and *3*) added for pick up from a cold start. The formula and definition of terms are given in connection with the charts, which cover two initial temperatures of room and iron (40 and 50 F). Time required for heating the metal and water content of the boiler is not



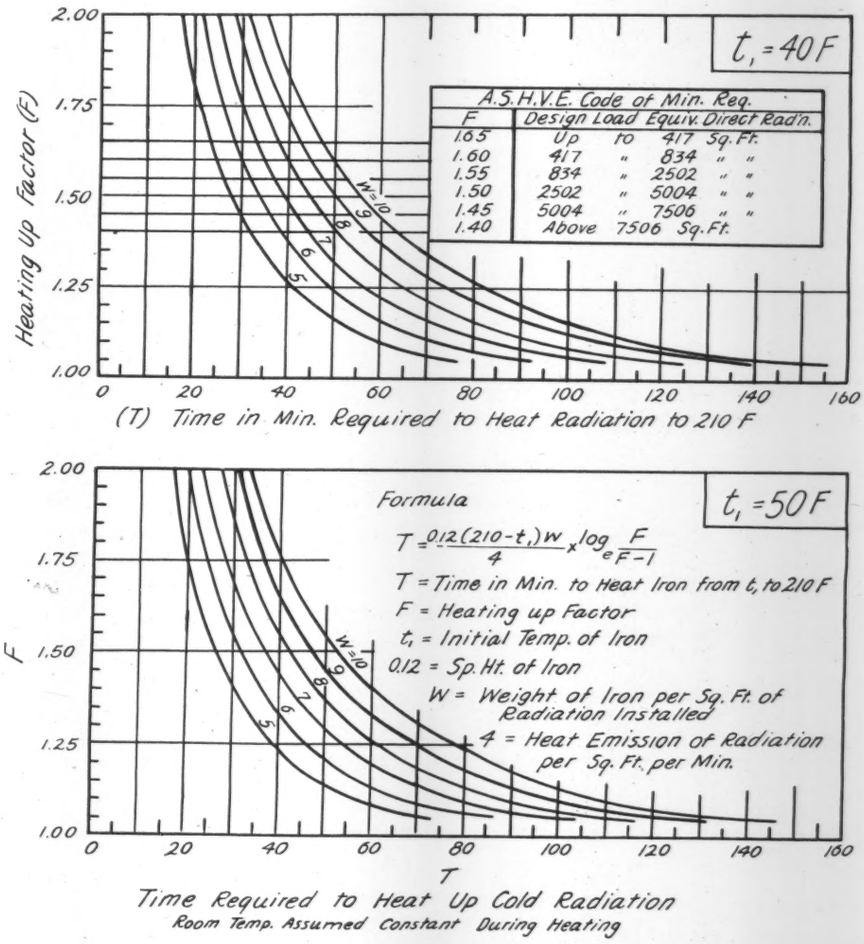


FIG. 6—TIME REQUIRED TO HEAT UP COLD RADIATION—STEAM SYSTEM

included. These charts apply to steam heating systems and do not include time required for warming up the boiler and its water content.

Application of the 50-F chart to solution of the Pulford substation problem can be made as follows: Since the formula relates boiler heat output to heat emission and heat absorption by the iron, it is necessary to determine the weight of metal per sq. ft. of equivalent column radiation (5932 sq. ft.). In this case the equivalent column radiation represents the sum of the standing radiation and piping tax converted to a column radiation basis, which was used in establishing the warming-up factor of 1.25. The weight of radiators, pipe and fittings per sq. ft. of equivalent column radiation is computed as 6.3 lb. Reading from the 50-F chart for 6.3 lb. and a heating-up factor of 1.25 gives 47 minutes time to bring the system up to operating temperature. This compares with the 43.4 minutes previously computed when not including the time required to bring the boiler itself up to temperature.

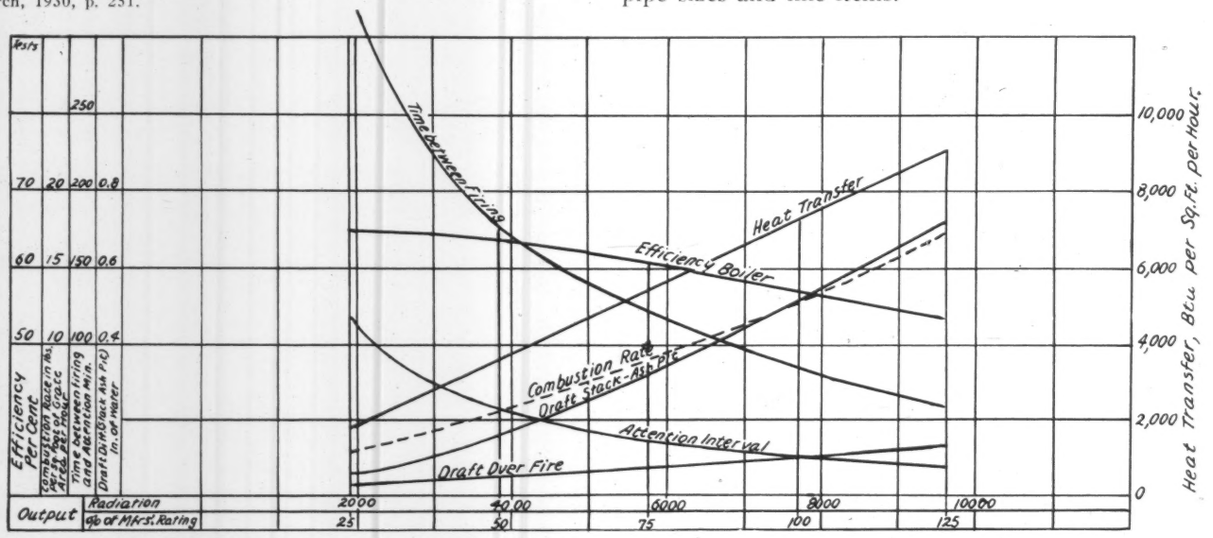
Use of Performance Curves Recommended

The use of performance curves in the selection of low pressure heating boilers is recommended by the *A. S. H. V. E.* committee for testing and rating steam heating solid fuel boilers.[5] Such curves should be based on actual tests conducted in accordance with the code formulated by that committee. According to the committee's recommendations performance curves should furnish data on the following items for at least five outputs ranging from maximum down to 35 per cent of maximum: (1) fuel available; (2) combustion rate; (3) efficiency; (4) draft tension; (5) chimney dimensions; (6) flue gas temperature. The only definite restriction placed on setting the maximum output is that priming shall not exceed 2 per cent. These curves are intended to provide the purchaser with complete data regarding performance of the boiler under test conditions. Certain other pertinent information such as grate area, heating surface and proper chimney dimensions are desirable also in forming an opinion of how the boiler will perform in actual service. In using such data for selecting a boiler it should be understood that they apply to test conditions and that equal performance or output may not be realized in service. In selecting a boiler from performance curves, therefore, a reasonable margin should be allowed for decreased output resulting from soot, poor fuel, or attention not the equal of that given on test.

Performance curves for a 36-in., cast iron, 13-section boiler burning high volatile soft coal are shown in Fig. 7. This boiler is similar to the Pulford substation boiler used in the example in this article, except that it has one less section. Fig. 7 furnishes the six items of data recommended above with the exception of flue gas temperature, which was not available. A heat transfer curve for the boiler surface has been added as of interest in view of the present importance attached to this item.

Information of the kind furnished in Fig. 7, coupled with reasonable experience on the part of the purchaser, should insure obtaining a boiler of adequate capacity. It is to be hoped that boiler manufacturers will make available more of such data in the future. It behooves the purchaser, however, to give as much thought to boiler selection as he does to computing building heat loss pipe sizes and like items.

[5] See report of committee in Heating, Piping and Air Conditioning, March, 1930, p. 251.



Boiler No.		
Mfr's. Rating	Sq. Ft.	7700
Grate Area	Sq. Ft.	18.0
Heating Surface	Sq. Ft.	253.8
Weight	Lb.	9160
Fuel Capacity	Lb.	651
Fuel Available	Lb.	414
Fuel Depth	In.	10

High Volatile, Bituminous ¾ Lump

Description

36-inch cast iron boiler, 13 sections, hand firing

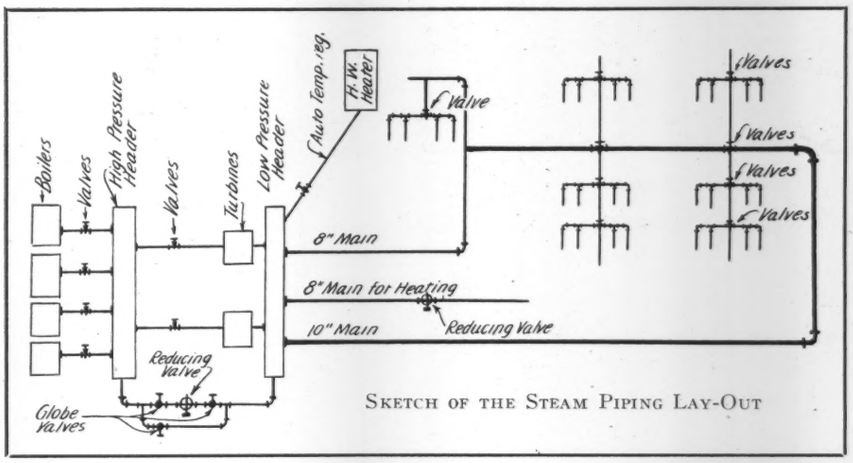
Fuel Analysis	%
Volatile Matter	34
Fixed Carbon	51
Ash	10
Sulphur	2
Moisture	3
Btu per lb.	13,655

Fig. 7 — Performance Curves for a Steam Heating Boiler

By Francis A. Westbrook*

Process Steam Reduced Through Turbines Saves in Cost of Power » » »

Piping Lay-out in Hat Factory Carefully Planned



SKETCH OF THE STEAM PIPING LAY-OUT

LARGE quantities of low-pressure steam for process work, which must be distributed to a great many points all over the plant, are used in making felt hats on a large scale. At the factory of Crofut & Knapp Co. (makers of Dobbs and Knappfelt hats) in South Norwalk, Conn., some 500 tanks are supplied with steam for use in the felting processes. The lay-out of piping for this service has been carefully planned and is of first importance.

165-lb. Steam Reduced Through Turbines

Steam is generated at 165-lb. pressure and is reduced through back-pressure turbines to 12 lb. The turbines are direct connected to generators which furnish practically all of the electrical power needed as a by-product. The turbines exhaust into a low-pressure header from which the main supply lines are run to the various tanks.

Process Steam Heats Water

Practically all of the process steam is used to make hot water by means of open-ended coils in tanks, the coil surface having been determined by experience. In the larger tanks the temperature is automatically controlled between 180 and 210 F, depending on the process, by means of a controller with the valve on the steam line and the bulb in the liquid. It has been felt to be impracticable for reasons of economy, as well as unnecessary, to install these controllers on the smaller tanks where the operations are manual and the workers must keep the temperature below boiling in any event. A large majority of these tanks are on the first floor although process steam is required on each of the four floors of the plant, and steam lines must be carried to them.

Three Mains Supply Low Pressure Steam

Referring to the diagram showing the general lay-out of the piping, it will be seen that there are four boilers connected with the main header from which the turbines are supplied. The exhausts from the turbines are turned into the low-pressure (or back-pressure) header from which steam is taken for heating and process work.

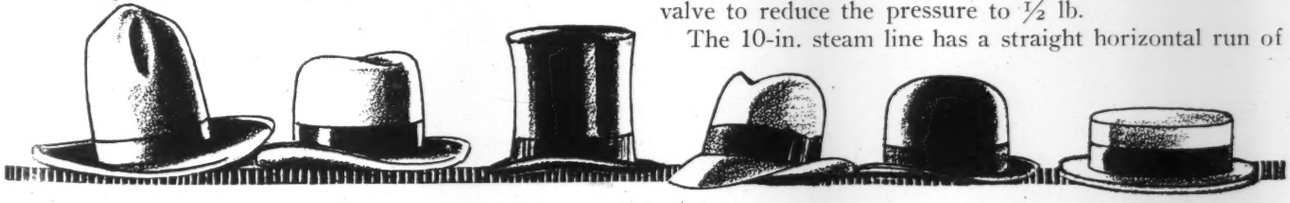
There is a connection between the low-pressure header and the boilers so that live steam can be admitted in case there is not enough exhaust steam. An automatic reducing valve is provided so that if the pressure on the low-pressure side drops below the predetermined point, live steam will be admitted to make up the deficiency. A by-pass has been provided so that the reducing valve may be cut out by means of globe valves.

A hot-water heater for process work is supplied with heating steam from the low-pressure header. This is provided with an automatic temperature regulator so that no more steam will be used than necessary.

Three main steam lines lead from the low-pressure header to carry steam to the plant. Two of these are 8-in. mains and the third is 10-in. One of the 8-in. mains carries steam for heating and is equipped with a valve to reduce the pressure to ½ lb.

The 10-in. steam line has a straight horizontal run of

* Consulting Engineer, Center Conway, N. H.



General View of the Forming Operation, Showing Several Machines and the Piping to the Dip Tanks

150 ft. It is provided with an expansion joint in the middle and is supported every 25 ft. on rollers to facilitate expansion and contraction. There are also individual intermediate hangers not provided with rollers. At the end of the 150-ft. run the pipe is carried up to the ceiling of the first floor. Lines branch off here to carry steam to the various tanks. Valves have been placed so that any branch can be cut off when desired.

The 8-in. process steam line has a comparatively short run in the basement and consequently does not have to be arranged to care for the stresses of expansion and contraction. On the first floor branches are also taken off for process work and the two mains are tied in to equalize the pressure.

Nothing smaller than 1-in. pipe is used at the individual machines. Steam is always fed from above so that the condensate will go through the open-ended heating coils in the tanks and into the water. Hot and cold water are also piped to each tank in the felting and dyeing departments so that the temperature and amount of water may be easily controlled.

Branches from the two low-pressure mains are carried to the upper floors where, however, steam is used in much smaller quantities.

Cost of Steam

In order to indicate the efficiency of the steam plant, the following extract from the power report is of interest:

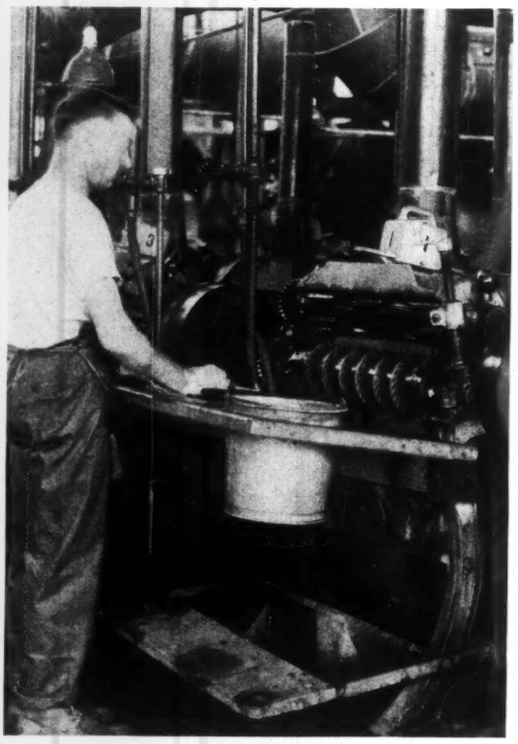
Kw-hr. generated	814,900	
Kw.-hr. from utility (night service)	65,620	
Feed water used in boilers	111,337,350	lb.
Total quantity of water used in factory (including boiler feed water)	30,715	gal.
Lb. of water evaporated per lb. of coal	10	
Average plant power factor	89%	
Coal used per year	5,431¼	tons
Cost of steam per 1,000 lb. (including labor, water, coal)	$0.37	

75% Make-up

Due to the considerable quantities of water absorbed by the felt in the felting processes, 75 per cent make-up water is needed. This is filtered and treated chemically for acid and alkali with sulphate of aluminum and silicate of sodium, respectively.

If all the power were purchased (814,900 kw-hr. in a year) the cost would be approximately $12,200.00. This is based on a power rate of $0.015 per kw-hr. which is the rate charged comparable consumers in the neighborhood. If the boiler pressure were not reduced through the back-pressure turbines, it would have to be reduced through reducing valves with approximately equal heat loss. However, in the first case the plant is supplied with electrical power, whereas in the latter case the heat is wasted. Consequently the sum of $12,200.00 is a fair measure of the saving realized. From this should be subtracted the annual charges on the generating equipment, figures for which are not available.

In busier years than that (1930), for which data are given in the above power report, the saving would be still more for the power used is about a million kw-hr. when the plant is running at full capacity.



Machine for Shrinking Hats to Size; Hats Are Dipped in the Hot Water Tank. After Dipping, Three or Four Bodies Are Wrapped in a Piece of Burlap and Placed in the Rolls for Manipulation and Pressure. Note the Hot and Cold Water Lines for the Individual Machine

There is vagueness and inaccuracy in the use of the terms static pressure, velocity pressure and total pressure, leading frequently to misconceptions and mistakes. Mr. Berestneff has included herein some of the definitions which occur in references and amplifies and explains them in detail here. By means of several examples, he shows just what the piezometer, the impact tube and the combined pitot tube measure when air flow is being studied or tested and discusses definitions.

Total, Static and Velocity Pressure

By A. A. Berestneff

THERE is considerable importance in establishing accurate definitions for total, static, and velocity pressures applied to the flow of air, as a review of current literature would reveal much vagueness and inaccuracy in the use of these terms.

This article is an attempt to bring some clarity to this question as well as to note the mistakes which are frequently made.

Definitions

Let us assume the following definitions:

Velocity pressure (VP) is that pressure which is required to create the velocity of air flow.

Static pressure (SP) is that pressure of compression, which, acting in all directions, tends to burst the pipe.

Total pressure—or impact pressure—(TP) is the sum of the static and velocity pressures.

This last definition is in accordance with Bernoulli's theorem:

$$TP = SP + VP$$

Two Cases Considered

Taking it as a base let us consider two different cases of a duct connected to a fan: (1) The duct connected to the delivery side of the fan, and, (2), the duct connected to the suction side of the fan.

In Fig. 1, assume that the TP-reading at the point of measuring is equal to 2 in. water, SP is 1 in. and VP is 1 in.[1] To avoid confusion let us use the absolute values of the pressures. Assuming atmospheric pressure as 408 in. (approximately 30 in. Hg.), the absolute value of TP would be 410 in. and $SP = 409$ in. VP will be 1 in., of course.

According to Bernoulli's theorem we can write:

$$TP = SP + VP = 409 + 1 = 410 \text{ in. (absolute)}$$

Or, using the gage readings,

$$TP = (+1) + (+1) = 2 \text{ in. (gage)}$$

TP is, of course, greater than SP and the positive reading of it given by the total pressure (impact) tube will be greater also, which is in accordance with the indications made on Fig. 1 for TP as shown by the total (or impact) tube, SP as shown by the static tube or piezometer, and VP as indicated by the combined pitot tube.

Now let us take the case of the suction side of a fan connected to a duct as shown in Fig. 2.

Assume for this case that $TP = 407$ in. (absolute), $SP = 406$ in. and $VP = 1$ in. Then:

$$TP = SP + VP = 406 + 1 = 407 \text{ (absolute)}$$

or in tube readings

$$TP = (-2) + (+1) = -1 \text{ (gage)}$$

From this equation it is seen that the gage reading for the total pressure must be less than the gage reading

[1] TP and VP readings are to be the average values of these readings for the whole cross-section of the duct.

for the static pressure, neglecting the minus sign. But in the above case a greater reading will be indicated (Fig. 2) by the piezometer. Consequently this reading corresponds to *SP* and the piezometer remains exactly as in the case of Fig. 1, a tube which measures *SP* so that we can call it the static pressure tube again. The reading corresponding to *TP*, as a lower one, will be shown by the impact tube, and all tubes will correspond to the indications made on Fig. 2. All of the above considerations are entirely in accordance with the definitions for *SP* as one which tends to burst the pipe.

Example Shows Misconception

Any other statement as to what is measured by the piezometer and what by the impact tube (sometimes the statement is made that for the suction side of a fan a piezometer measures *TP* and an impact tube measures *SP*) would lead to a contradiction of Bernoulli's theorem and with our definition of *SP*.

Suppose we should accept this statement, which is from a standard text: "The static or piezometer tube on the suction side gives total pressure, that is, it includes the velocity pressure, and the pitot tube (impact tube) gives the static pressure." In this case, referring to Fig. 2, we should have to change the indications made for *TP* and *SP*, placing the first under the piezometer and the latter under the impact tube. It therefore follows that *SP*, the reading of which would be equal to 1 (being negative), should equal 407 and *TP*, the reading being equal to 2 (also negative), should equal 406. *VP* will keep the same value of 1 in. Applying Bernoulli's theorem, we should have

$$TP = SP + VP = 407 + 1 = 408,$$

as compared with 406 as given by the piezometer. Or expressing it in readings

$$TP = SP + VP = (-1) + (+1) = 0$$

against an actual reading of —2 taken by the piezometer. Consequently it is not the piezometer which measures total pressure. From this example it will be seen that the above quotation would lead us to results not in accordance with Bernoulli's theorem.

We could arrive at the same conclusions as to the incorrectness of the above statement by asking: How can an impact tube having the axis of the opening directed against the air flow measure the static pressure only, eliminating the impact action of the flow on the reading of the tube? But if it does not eliminate this action—in other words, if it includes both the influence of compression (due to static pressure) and the influence of impact (due to velocity pressure)—then the resulting reading taken by this tube is the *TP*-reading and not the *SP*-reading.

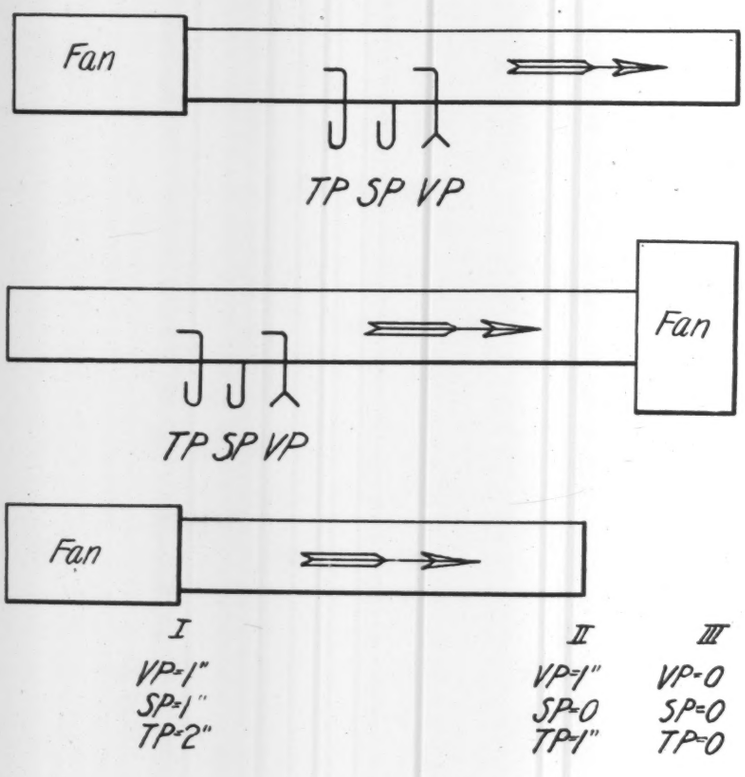
Various Cases Illustrated

Let us consider some numerical examples of air flow for different cases.

Discharge Duct: In Fig. 3 considering points II and III (the latter represents the condition of the surrounding air) we see that the difference between VP_{II} and VP_{III} is equal to 1 in. If there were 100 per cent of conversion and no losses between II and III, then *SP* at II would be equal to —1 in. and consequently $TP = 0$. Assuming a 100 per cent loss, we would have $SP_{II} = 0$ and $TP_{II} = 1$, as indicated on the Fig. 3. Assuming friction loss between I and II equals 1 in., the conditions at point I would be as indicated on the same Fig. 3.

Suction Duct: Let us now consider a similar example for the suction side of the fan (Fig. 4). The difference between VP_I and VP_{II} is equal to 1 in. If there were 100 per cent conversion and no loss between I and II, then SP_{II} would be equal to —1 in. and consequently $TP_{II} = 0$. Assuming a 1 in. loss (in this case, of course, not only a friction loss inside the duct, but some loss at the entrance of the duct due to contraction of the flow) between II and III we will have the conditions at III as indicated on Fig. 4.

Considering point II we see that to create



Top to Bottom

FIG. 1—DUCT CONNECTED TO DELIVERY SIDE OF FAN (See example in text)

FIG. 2—DUCT CONNECTED TO SUCTION SIDE OF FAN (See example in text)

FIG. 3—NUMERICAL EXAMPLE ILLUSTRATING MEASUREMENT OF TOTAL, STATIC AND VELOCITY PRESSURE WHEN DUCT IS CONNECTED TO DISCHARGE (See example in text)

Top to Bottom

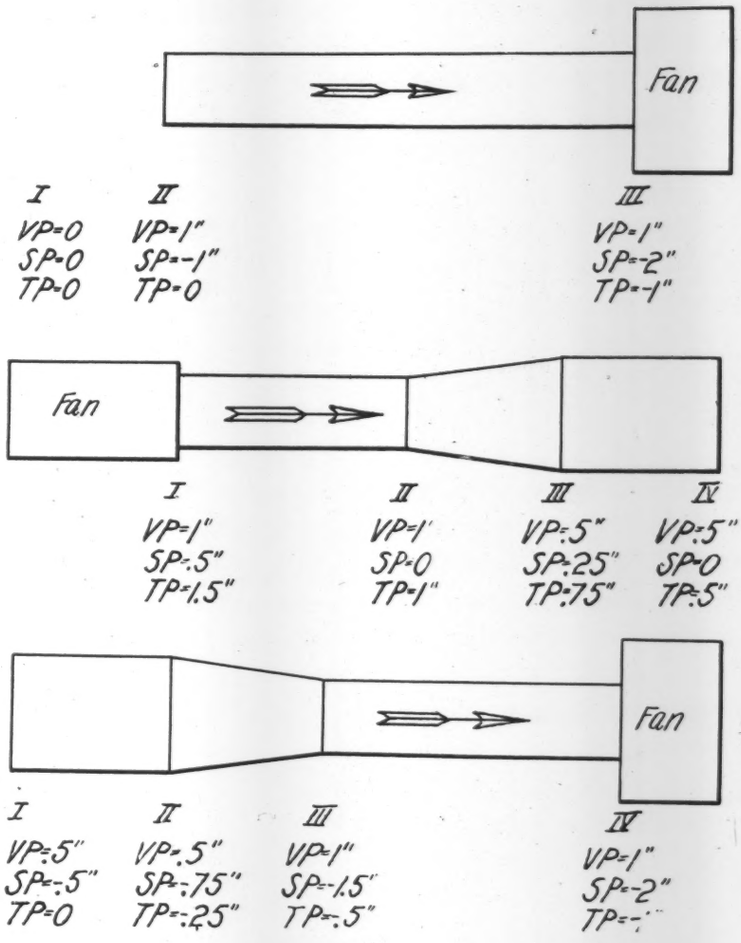


FIG. 4—NUMERICAL EXAMPLE ILLUSTRATING MEASUREMENT OF TOTAL, STATIC, AND VELOCITY PRESSURE WHEN DUCT IS CONNECTED TO SUCTION (See example in text)

FIG. 5—DUCT OF VARYING CROSS SECTION CONNECTED TO DISCHARGE (See example in text)

FIG. 6—DUCT OF VARYING CROSS SECTION CONNECTED TO SUCTION (See example in text)

$VP_{II} = 1$ we must have some suction at II which is expressed by $SP_{II} = -1$. Corresponding to a 1 in. loss inside the duct SP_{III} is equal to —2 in.

Duct with Varying Cross Section: Up to this point we have taken the simplest cases of a duct connected to a fan, namely the cases where the area of the duct cross section remains constant and consequently the outlet velocity keeps the same value as the velocity at the entrance of the duct. Let us analyze a more complicated case—a duct with a changing cross section. One of these cases, namely for delivery side of the duct, is shown in Fig. 5.

Suppose a duct with a transmission piece between points II and III such that the velocity pressure in the section from III to IV will be 0.5 in. against 1 in. in part I-II. Applying the same method as in the case of Fig. 3 we will find that at the point IV, $VP = 0.5$, $TP = 0.5$, and $SP = 0$. Assume the loss between all these points is equal to: I-II = 0.5, II-III = 0.25, III-IV = 0.25 (the first and third being pure friction losses, the second, friction and turbulence). The sum of all losses is then equal to 0.5 + 0.25 + 0.25 = 1 in., i. e., the same as on Fig. 3.

At the point III, VP (being the same as for the point IV) will be = 0.5, TP, due to the loss between III and IV, will be = 0.75, and $SP = 0.25$. For the point II we will have $VP = 1$, TP, due to the loss between II and III, will be 1, and consequently $SP = 0$. This zero value of static pressure is explained by the fact that between II and III, two factors influence the change of static pressure: First, the loss equal to 0.25, so that SP required to overcome the whole loss to the end of the duct would be equal to 0.25 + 0.25 = 0.5, and second, the increase of SP between II and III which corresponds to the decrease of VP (conversion of VP into SP). The latter is equal to 1 —0.5 = 0.5. Consequently the increase of SP will be 0.5 also and the final SP value at the point II will be +0.5 —0.5 = 0. At the point I, due to the loss between I and II, $TP = 1.5$, $VP = 1$, and $SP = 0.5$.

Suction Duct with Varying Cross Section: As a last case let us take the example of a similar case for the suction side of the fan. Assume (Fig. 6) the losses between I and II = 0.25, II-III = 0.25, and III-IV = 0.5. Then applying the same method for determination of conditions at points I, II, III, and IV, we will have TP, SP, and VP as indicated on Fig. 6.

References Analyzed

Let us now look at some examples of definitions of total and static pressures as found in various text-books:

> "The total or impact pressure is the sum of pressures required to overcome the resistance to flow and create the velocity of discharge."

We could accept this definition if we will understand the resistance to flow is the sum of all losses of energy inside the duct plus the counter-pressure at the end of the duct (i. e., SP_e) which, of course, also must be overcome by the total pressure at the beginning of the duct. It is quite logical that this resistance plus the outlet velocity pressure will give total pressure at the beginning of the duct. Expressing all pressures in absolute values we can write:

$$TP_b = \overbrace{\Sigma \text{ losses} + SP_e}^{\text{resistance}} + VP_e \qquad (1)$$

where b indicates pressure at the beginning of the duct and e, pressure at the end of the duct.

Taking the examples of Figs. 5 and 6, we have for delivery side (Fig. 5):

$$TP_b = 1 + 408 + 0.5 = 409.5 \text{ (absolute)}$$

which is in accordance with the TP-reading at the beginning of the duct (1.5 in. gage).

For the suction side (Fig. 6)

$$TP_b = 1 + 406 + 1 = 408 \text{ (absolute)}$$

which corresponds to the TP-reading at the beginning of the duct (0 gage).

Let us now endeavor to prove the accuracy of the following definition for static pressure:

"The static head or pressure is that pressure required to overcome the resistance offered to the flow."

We can write Equation 1 as follows:

$$TP_b = SP_b + VP_b = \Sigma \text{ losses} + SP_e + VP_e, \text{ or}$$

$$SP_b = \overbrace{\Sigma \text{ losses} + SP_e}^{\text{resistance}} + (VP_e - VP_b)$$

From this equation we see that the above definition of SP, considering only the first two terms of the right-hand part of the equation and neglecting the third one, is not correct as a general definition. It should be expressed as follows:

"The static head or pressure is that pressure required to overcome the resistance offered to the flow plus the increase of velocity pressure from the beginning to the end of the duct."

Taking, for instance, the example of Fig. 5 and using the above *incorrect* definition, we would have:

$$SP_b = 1 + 408 = 409$$

i. e., the corresponding reading should be 1 in. instead of 0.5 in. as indicated on the figure, thus proving the incorrectness of the first definition.

Considering the example of Fig. 6 and applying the corrected definition, we have:

$$SP_b = 1 + 406 + (1 - 0.5) = 407.5 \text{ (absolute)}$$

which is entirely in accord with the indication made on Fig. 6 for SP at the beginning, equal to —0.5 in. gage.

After we know the expression for the absolute value of TP at the beginning of the duct necessary to produce air flow with the outlet velocity pressure VP_e and against a static pressure of discharge SP_e (Equation 1), we will try to answer this question: What is the energy we must supply to create this flow and by what is it measured?

It is clear that, referring to Equation 1, this energy, expressed in pressure units, is represented for all cases by Σ losses $+ VP_e$, because SP_e is already existing in the atmospheric pressure, being equal to the latter for the delivery side and less than that for the suction side. (Here we are speaking of the case where the duct is connected to the atmosphere). Now subtract from both sides of Equation 1 the value of atmospheric pressure (AP) and write:

$$(TP_b - AP) = \Sigma \text{ losses} + (SP_e - AP) + VP_e \qquad (2)$$

We see that all pressures are now represented in their reading values.

For the delivery side, $SP_e = AP$. Calling $TP_b - AP = TP_{br}$ = total pressure reading at the beginning of the duct, we can write Equation 2 thus:

$$TP_{br} = \Sigma \text{ losses} + VP_e \qquad (3)$$

For the suction side:

$$TP_b = AP.$$

Calling $SP_e - AP = -SP_{er}$ = static pressure reading at the end of the duct (minus because AP is greater than SP_e) we write Equation 2 as follows:

$$0 = \Sigma \text{ losses} + (-SP_{er}) + VP_e, \text{ or}$$

$$SP_{er} = \Sigma \text{ losses} + VP_e. \qquad (4)$$

And from Equation 1 we have:

$$TP_b - SP_e = \Sigma \text{ losses} + VP_e.$$

From this last equation we see that the energy we must supply to create a flow of air in the duct, expressed in pressure units, is equal to the difference between TP at the beginning of the duct and SP at the end of the duct.

From Equations 3 and 4 we come to the conclusions:

"In the case of the delivery side, it is the TP-reading at the beginning of the duct (taken by the impact tube) which measures the energy necessary to create a flow.

"In the case of the suction side it is the SP-reading (taken by the piezometer) at the end of the duct (always in the derection of flow) which measures the energy necessary to create a flow." [2]

An attempt to express the energy necessary for both cases (delivery and suction side) by the TP-reading—as one can find it in some books—is incorrect, being the result of a wrong representation of that which is measured by the static tube and that which is measured by the impact tube.

Conclusions

The following conclusions may be drawn:

1. One must be very careful when giving definitions of total, static, and velocity pressures because incorrect definitions easily cause incorrect representations. [3]
2. One must be very careful in using these terms (especially total and static pressures) because there is a great difference between them when applied to the air flow characterizing the conditions of flow at any point and the same terms as applied sometimes for expressing the energy to be supplied to create a flow or for expressing the total and static pressures as developed by a fan.
3. As to the measurement of their quantity the piezometer or static tube located at any point always gives static pressure reading and the impact tube (or simple pitot tube) always gives total pressure reading at this point.
4. It is better to use only these three terms expressing the corresponding conceptions, namely: total, static, and velocity pressures (or heads) eliminating all other terms which cause difficulties in understanding (like the terms frictional or resistance pressure used instead of static pressure).
5. It is better to express total, static and velocity pressures in their absolute values, starting from zero. (When using these terms as applied to the determination of conditions of air flow at any point of flow.) This will prevent wrong conclusions caused mostly by the consideration of direct readings as given by tubes.

[2] In the above the duct is considered separately from the fan as an independent system of air flow, i. e., we do not consider the eventual changes which could occur in the flow inside of the attached fan. In other words, the discharge velocity pressure at the end of the duct is considered to be entirely lost.

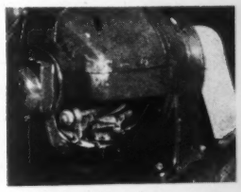
It is clear that by means of a special design of a fan outlet we could decrease the outlet velocity of discharge at the fan outlet as compared to the velocity at the end of the duct, thus decreasing the energy necessary to create a flow through the same duct system and the attached fan. (That is the reason a piezometer reading taking at the end of a duct connected to the suction side of a fan does not always measure the total pressure developed by the fan.)

[3] The writer does not assert that the definitions given at the beginning of this article are absolutely correct, although they seem to be sufficiently exact for expressing their physical sense. The objection made sometimes against the definition of static pressure as one which tends to burst the pipe because in a bend of the pipe the bursting effect is created not only by the compression due to static pressure but also by the impact of the flowing air, seems to be non-essential. When the air flow meets the pipe wall of a bend the kinetic energy of the impact is transferred (wholly or partially) into the static energy of compression, thus increasing the value of the static pressure at this point. Therefore in the case of a bend there seems to be no contradiction with the given definition of static pressure.

Editor's Note: A discussion of this subject by L. A. Harding will appear next month.

Knowledge of Electrical Fundamentals Saves Costly Mistakes

Ignorance of the fundamentals of electricity and of the principles of operation of electrical equipment leads to many costly mistakes in selecting electric drives for pumps, unit heaters, fans, oil burners, compressors, etc. This article points out those basic facts that constantly should be kept in mind.



By Milton K. Arenberg*

ELECTRICALLY-driven pumps, unit heaters, fans, blowers, humidifiers, refrigerating machines, oil burners, compressors, control apparatus and numerous other electrical items are being purchased in greater quantities each year by the heating, piping and air conditioning engineer and contractor. Costly errors can be avoided by thorough knowledge of the fundamentals of electricity.

Electricity is distributed as direct current or alternating current. The distribution of direct current, commonly referred to as d.c., is steadily decreasing in practically all cities and is being replaced by alternating current (a.c.) because of the greater economies in the distribution of it and the greater distances that it can be carried.

In direct-current equipment specifications it is necessary to state only the voltage of the circuit, the most commonly used being 115, 230 and 500 volts.

Specifying the Motor

Direct Current: D. c. motors consist of a rotating part called an *armature* and a stationary part known as the *field*. The commutator is a part of the armature and has all the armature coils connected to it and the motor brushes make contact on it. There are three ways of connecting the armature and the field (as shown in Fig. 1); these are known as series, shunt and compound windings. They each provide different motor characteristics, but if the motor manufacturer knows the type of equipment to be driven he can furnish the type of winding best suited.

Many cities have laws which require that all live electrical contacts be so covered that a person cannot accidentally touch them. Therefore it is necessary to know if such an ordinance is in force. If it is, it is necessary to specify that the commutator end of the motor be enclosed or semi-enclosed by a suitable guard and that all contacts on speed regulating equipment be totally enclosed. Semi-enclosure has the advantage that the commutator and brushes can be seen without removing the cover and this sometimes prevents a motor running with worn down brushes. Some manufacturers furnish all direct-current apparatus enclosed as standard equipment.

Alternating Current: With alternating current it is necessary to specify the frequency of the circuit in cycles, and the number of phases as well as the voltage. The most common frequency is 60 cycles although 25, 30, 40, 50 and 133 cycles are in use. Steel mills are probably the largest users of 25-cycle current. The usual phases are single, two and three. The usual voltages are 110 and 220 on single phase and 220, 440 and 550 on two-and three-phase. The city of Grand Rapids, Michigan is an exception with 480 volts and 30 cycles, although this is gradually being changed over to 440 volts and 60 cycles.

Phase: The most common mistake made by engineers and contractors is in procuring the proper phase. When questioned on this point they may ask which is the cheaper and then select three-phase because it is. The error is not discovered until the electrical contractor comes on the job, and nothing can be done except to remove the motor and return it to the manufacturer or purchase a condenser-type phase converter. A. c. electrical circuits for lighting purposes are single-phase current and are 110 volts. A. c. circuits for power purposes are either 220 volt, single phase, or 220 volt or 440 volt, 3 phase, so that the information that power service is available at the building does not necessarily mean that three-phase is available.

Nor can the phase be determined by the number of wires coming into a building, because three-phase requires three wires and 220 volt, single-phase, is furnished through three wires also. If the wiring in the building connects to an outside wire of a 220 volt, single-phase service in the cut-out cabinet, and also to the middle wire, 110 volts are obtained. If it connects to the two outside wires 220 volts are obtained, as indicated in Fig. 2.

Most public utility companies require a connected load of 5-hp. or more before they will supply three-phase service. Otherwise they will furnish only 220 volt, single-phase, for power. The best way of determining the phase in a new building is to find out whether all motors used will total 5-hp. If the plans show an elevator in the building the motor used will be a 5-hp. or more and three-phase will be available at the building. However, if the elevator is operated by the owner of the building and the installation is being made for a tenant, three-phase will not be available to the tenant unless he has a 5-hp. load connected to his own meter.

The distribution department of the local power company will be glad to supply authentic information if any question arises.

A. C. Motors: The rotating part of an a.c. three-phase

*Chicago district manager, Ilg Electric Ventilating Co.

squirrel cage motor is called the *rotor* and the stationary part is called the *stator*. The rotor has no wire winding on it. It consists of a series of steel laminations or thin steel plates pressed together and having copper bars through them which are welded to copper retaining rings on the ends of the rotor. No brushes are used with constant-speed, squirrel cage polyphase motors, thus facilitating maintenance. The stator, of course, is wound with coils of copper wire. The simplicity of construction of the squirrel cage two- and three-phase motor accounts for its popularity and is largely responsible for the development of the single-phase capacitor-type motor which is really a two- or three-phase motor operating on a single-phase circuit by means of a series of condenser cells connected across one of the phases in order to produce starting and running torque.

A *split-phase* motor is a single-phase motor with two windings, one for running duty and the other connected in series with a centrifugal switch for starting purposes only. The current is run to the centrifugal switch through contact brushes and when the motor attains a definite speed the circuit is automatically opened to cut out the starting winding, leaving the motor running on the main winding.

A variable-speed three-phase alternating-current induction motor is called a *slip-ring* motor. The rotor in this type of motor usually consists of wires wound in insulated slots with the end of each wire connected to rings upon which brushes ride to carry the rotor current to the external resistance controller which is used to reduce the speed.

Miscellaneous Points to Remember

Single-phase motors having a starting current of not over 15 amperes may be operated on 115 volts according to the rulings of most cities and utilities. Over 15 amperes must be connected to 220-volt circuits. A motor ordinarily requires four times the current (in amperes) when starting that it requires when running at full speed.

One horsepower equals 746 watts output. For direct current watts = volts × amperes. For a. c. the power factor must be considered which usually can be roughly estimated at 0.85; therefore a. c. watts equal approximately 0.85 × volts × amperes.

Electricity is paid for on the basis of a definite charge for each one thousand watts per hour (kw-hr.) input or consumption. Therefore, unless the watts input is given or the electrical efficiency of the motor is stated the exact cost of operation per hour cannot be determined.

It can be estimated approximately, that an a.c. motor requires between 850 to 900 **watts input** for each 1 hp. (746 watts) output of work. Brake horsepower (b. hp.) is the horsepower output.

The **electrical efficiency** of a motor is usually highest at 100 to 115 per cent of full load.

A.c. motors can be made to operate at only certain **full-load constant speeds** depending on the frequency of the circuit. 285, 340, 380, 425, 490, 570, 690, 850, 1140, 1750 and 3400 are rated 60-cycle speeds although they will vary a few r.p.m. depending on the *slip* of the rotor. 720 and 1420 are standard 25-cycle speeds.

Three-phase motors should have **phase failure protection** fuses so that if one fuse blows the motor will stop and not run on only one phase and possibly burn out. Starting switches can be purchased which are equipped with thermal devices which will open the circuit and which can be reset easily.

Motors under 5-hp. usually can be thrown directly on the line. Over 5-hp. they should have an **automatic starter** to throw the load on the line gradually.

Universal motors are those which will operate on either a.c. or d.c.; they are generally used only in fractional horsepower sizes.

Internal connection changes must be made to reverse the **direction of rotation** of direct-current and single-phase motors. Three-phase motors can be reversed by interchanging any two leads at the motor or at the switch as shown in Fig. 3.

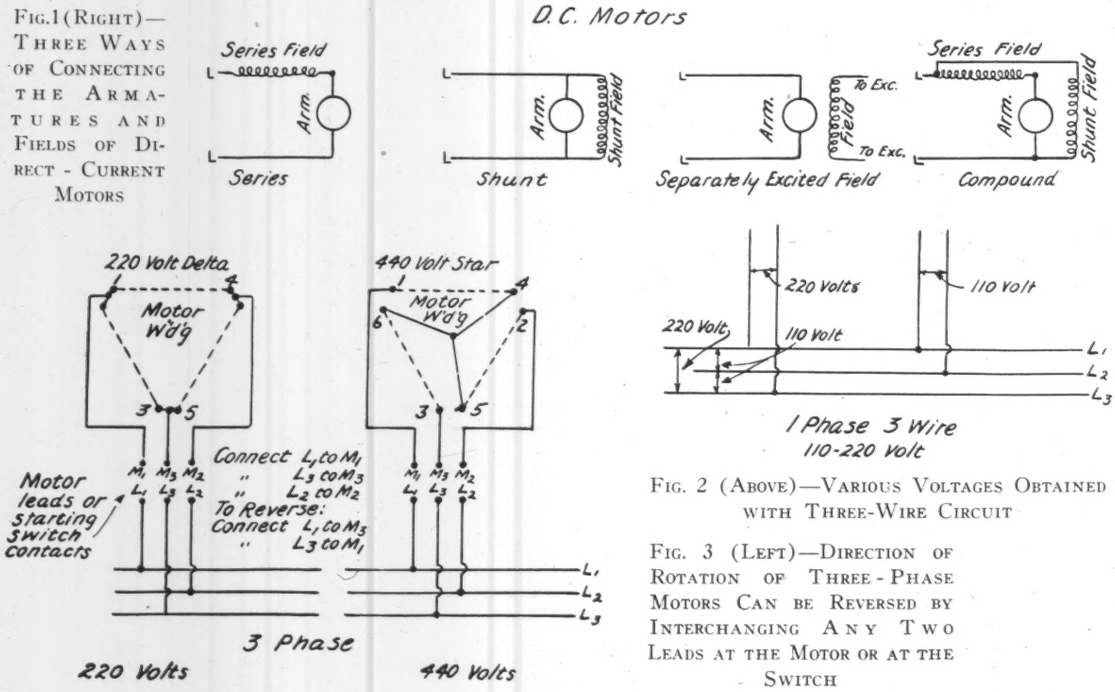


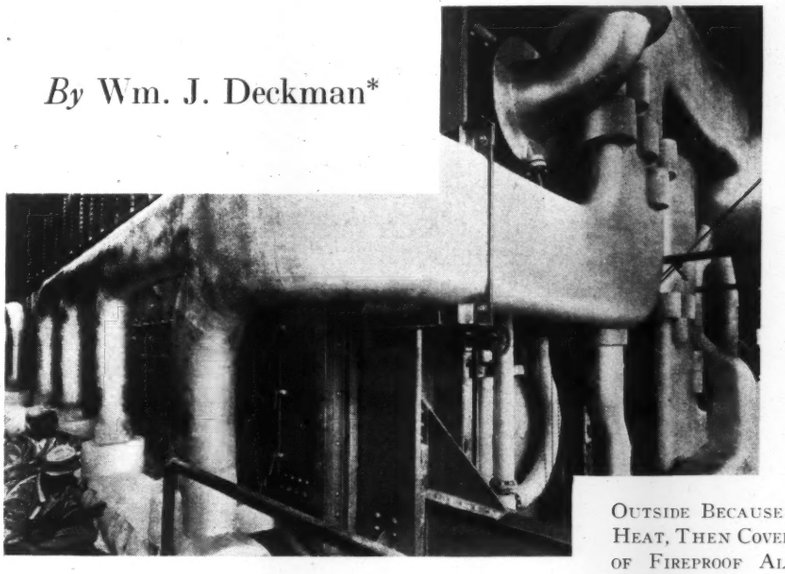
FIG. 1 (RIGHT)—THREE WAYS OF CONNECTING THE ARMATURES AND FIELDS OF DIRECT-CURRENT MOTORS

FIG. 2 (ABOVE)—VARIOUS VOLTAGES OBTAINED WITH THREE-WIRE CIRCUIT

FIG. 3 (LEFT)—DIRECTION OF ROTATION OF THREE-PHASE MOTORS CAN BE REVERSED BY INTERCHANGING ANY TWO LEADS AT THE MOTOR OR AT THE SWITCH

Asbestos Cloth . . . . Protects Insulation . . on Piping Near Boilers

By Wm. J. Deckman*



PIPES PROTECTED WITH ASBESTOS CLOTH SEWED WITH ASBESTOS THREAD ON OUTSIDE BECAUSE OF TREMENDOUS HEAT, THEN COVERED WITH A COAT OF FIREPROOF ALUMINUM PAINT

POWER plant insulation plays an important part in the economical production of power. The success of the Deepwater power station, Deepwater, N. J., one of the first central stations built for 1250-lb. operation, is a good illustration of this. This plant was designed for an ultimate capacity of 400,000 kw. The installation consists of two 53,000-kw. cross-compound turbine units, one for each of the two utility companies, and a 12,500-kw. turbine-generator supplying an adjacent industrial plant. All turbines are designed to operate on steam at a pressure of 1250 lb. and a temperature of 725 F.

On the water wall circulating tubes of the boilers, there was applied a double standard thick covering, the inner layer with high temperature covering and the outer layer with high-grade 85 per cent magnesia. As the boilers continued in operation, the radiation from their walls and exposed steel parts was so great that the insulation covering originally applied charred and sometimes ignited, due to exterior heat and not from heat beneath the insulation.

Asbestos cloth was then placed on the outside of the insulation on the tubes from the upper headers up to the boiler drums, including the header. This took care of the upper part of the boiler; later it was decided, this having proved satisfactory, that all piping directly adjacent to the boilers should be finished with asbestos cloth. Asbestos cloth was also used on the steaming tubes from the economizer to the boiler drums which are banks of 2-in. pipes. Each time a boiler was closed down these tubes developed leaks and after packing was replaced, the tubes had to be re-insulated. It was impossible to do this work when the boiler was in operation, due to the high temperature. Doing this job over a number of times ran the cost of insulation very high.

Blankets of asbestos cloth 2-in. thick were filled with 85 per cent magnesia cement and quilted. These were made in sections so that they could be easily handled and sewed with asbestos thread. For the quilting a soft No. 16 copper wire was used. Along the edges of the blankets, ½-in. grommets were fastened so they could be laced together with copper wire. These blankets were slipped over the lower row of pipes along the edge and across the top, making, as nearly as possible, an air-tight compartment. These have been removed several times on various boilers and have been replaced without trouble.

There is another purpose for which this particular type of blanket may be used to an advantage, such as for insulating high pressure water pumps. Pumps of this type need more or less servicing and it is expensive to replace the insulation. The blankets are made in sections to fit the contours of the equipment. They can be taken off and replaced at will, and have proved their value.

Asbestos cloth with approximately 85 per cent asbestos fiber and 15 per cent cotton should be used for this type of work; a cloth with too great a cotton content would not be satisfactory.

*Sales Engineer, Keasbey & Mattison Company, Philadelphia, Pa.

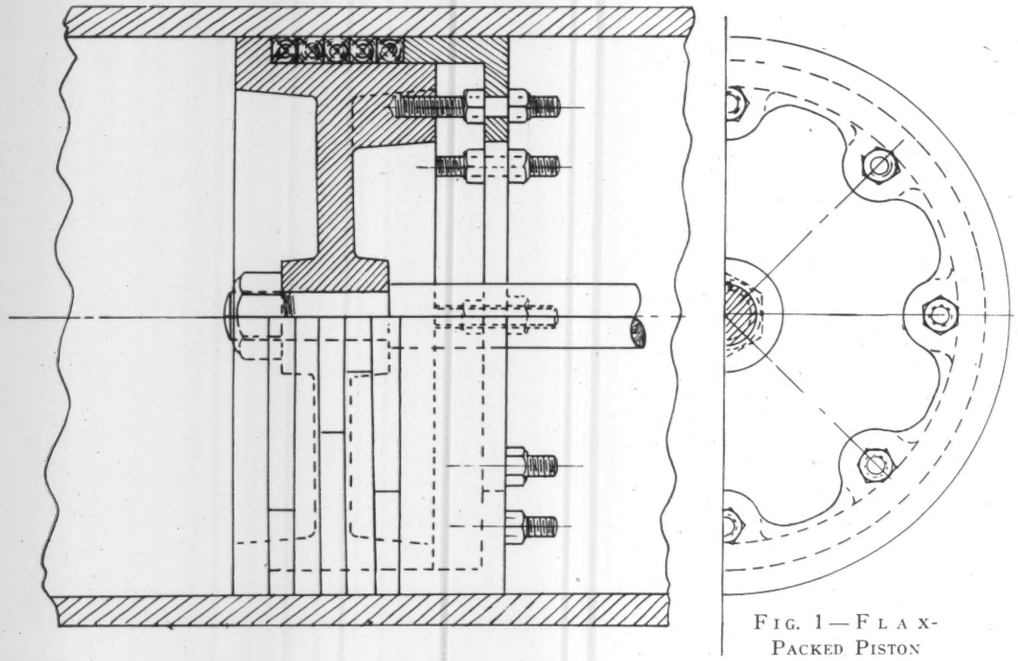


FIG. 1—FLAX-PACKED PISTON

[Gaskets and Packing for Hydraulic Power]

By F. E. Wertheim*

WATER under pressure as a means of transmitting power has certain advantages, especially for operations where great force is to be exerted through a comparatively short distance. Thus the use of hydraulic machinery has become common for lifting, shearing, punching, riveting, bending, forming, flanging, forging, and butt-welding operations, as well as for heavy press work such as extracting cottonseed oil, producing plastic molded parts, and extruding metals. Another valuable development of hydraulic machinery has been for variable speed devices.

Advantages of Hydraulic Power

For the uses mentioned, the capacity, simplicity, dependability, ease of maintenance, silence and speed of hydraulic machines are noteworthy. The hydraulic tool or machine consumes power only during the work interval; a store of energy, instantly available, obviates waiting for machinery to get into motion; a small pipe filled with water transmits energy from generator to machine; and the energy stored while running a pump for some minutes may be utilized during several seconds of machine operation. A fact not very widely appreciated is that well designed hydraulic equipment is exceptionally speedy and may become the means to a maximum production of manufactured articles.

Use Appears to Be Increasing

In spite of the qualities just enumerated and the possibilities of economy and high efficiency, the use of hydraulic equipment declined appreciably during a period which began about 1880. However, in recent years, use of hydraulic presses and hydraulic actuating mechanisms appears to be increasing in many industries, with a tendency toward self-contained types of presses.

Packing Piston for Hydraulic Cylinder

Flax packing (outside packed when feasible) is frequently used when conditions permit. Fig. 1 shows a piston for a hydraulic cylinder, the follower ring being locked to prevent jamming the flax packing in the cylinder. When the stuffing box and gland design is not practicable, the design shown in Fig. 2 may be used. The leather rings fit the cylinder closely, the separate

* Mechanical engineer, Chicago, Ill.

washers composing the rings being pegged and cemented together. Water enters the space behind the rings through drilled holes, thus pressing the rings against the surfaces to be packed. Recently, soft rubber bearings have proved to be very satisfactory where submerged or lubricated with water—even in dredges where exposed to silt and grit. Hence a soft rubber packing might be well worth trying in the arrangement shown in Fig. 2. The writer also proposes the use of soft rubber for such places as where cup leathers are used. (Editor's Note: Since this article was written, U-type hydraulic packing of rubber for hydraulic rams and presses has been made available for pressures up to 3000 lb. and more.)

Pipe Joints

Red fiber makes a satisfactory packing ring for pipe joints, especially when held in a recess or groove. It has been used successfully for 2¾-in. I. D. pipe subjected to pressures up to 8000 lb. per sq. in.

When joints are so located that heat may cause deterioration, copper gaskets may prove advisable. It has been found that commercial copper, 0.125 in. thick, will

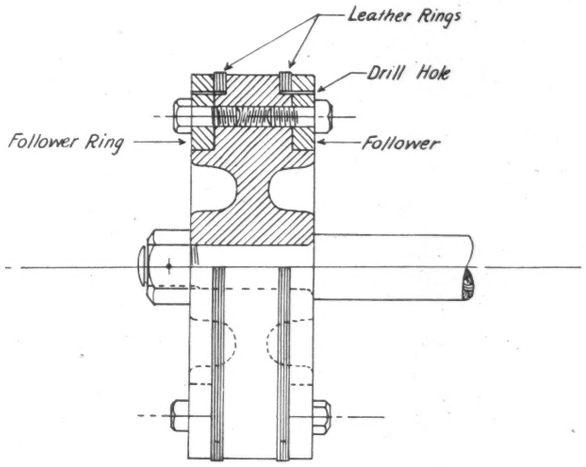


FIG. 2—LEATHER-PACKED HYDRAULIC PISTON

flow at a pressure of 60,000 lb. per sq. in. Taking advantage of this, grooves can be cut into the surfaces against which the gasket rests so that the gasket will take the shape shown in Fig. 3.

Designing a Copper Gasket

Let us consider the design of such a gasket. We assume the gasket to be an unconfined copper ring, 0.125 in. thick; diameter of pipe or cylinder to be 9 in. and pressure, 4000 lb. per sq. in.

The coefficient of friction may be taken as 0.15; hence for the double surfaces it will be 0.3. As the result of experiment, it has been found that a constant $C = 2.5$ should be introduced into the theoretical formula for the normal load, L, required to keep the gasket from blowing out.

The theoretical formula is $L = P/0.3$

The empirical formula is $L = \dfrac{P \times 2.5}{0.3}$

Then, for the case assumed above:

$$L = \frac{4000 \times 0.125 \times 2.5}{2 \times 0.15} = 4{,}167 \text{ lb. per in. of length of inside diameter.}$$

To the normal load above must be added the load per inch of inside diameter, W, due to internal pressure:

$$W = \frac{9^2 \times 0.7854 \times 4000}{9\pi} = 9{,}000 \text{ lb.}$$

Hence the total load per inch length of gasket = 9000 + 4167 = 13,167 lb.

∴ Gasket width = 13,167 ÷ 60,000 = 0.22 in.

In figuring bolting it is advisable to increase the computed width of gasket. Using a width of 0.375 in., the mean diameter of gasket = 9⅜ in., and the gasket area = 9.375 × π × 0.375 = 11 sq. in. The total load on the bolts will be 11 × 60,000 = 660,000 lb. Design of bolts need not be considered here.

The gasket just considered is subjected to a pressure which will cause flow of the metal into the triangular grooves functioning to seal the joint. With adequate bolting, the intensity of pressure on the gasket will be 60,000 lb. per sq. in. Any pressure in excess of this will cause the copper to flow and the resulting increase in area will bring about equilibrium at a gasket pressure of 60,000 lb. per sq. in.

With totally enclosed gaskets it is unnecessary to apply pressure for the purpose of keeping the gasket from being blown out. Therefore it becomes practicable to reduce the gasket area, and consequently the bolt loading.

Use of Soft Iron Gaskets

The writer has not come upon any reference to the use of soft iron gaskets in hydraulic service. Such gaskets are now used successfully for steam pressures of 1350 lb., and soft annealed iron might prove very satisfactory for hydraulic service.

Piping Should Be Constrained to Avoid Whip

Water hammer is to be avoided, but as this is most difficult to determine in advance, good practice consists in careful selection of formulas; and working fiber stresses not over half the elastic limit of materials to be used. Piping should be constrained so as to avoid whip due to water hammer.

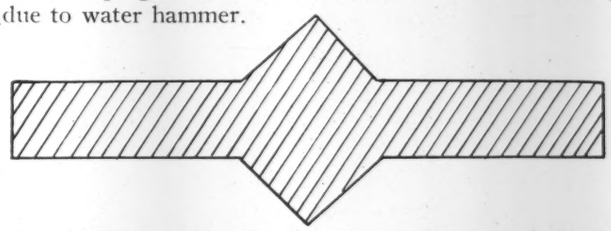


FIG. 3—GROOVES CAN BE CUT IN THE SURFACES AGAINST WHICH THE COPPER GASKET RESTS SO THAT IT WILL TAKE THIS SHAPE, AS COMMERCIAL, 0.125 IN. THICK, COPPER FLOWS AT 60,000 LB. PER SQ. IN. DEPTH OF GROOVES IS EXAGGERATED IN THIS SKETCH

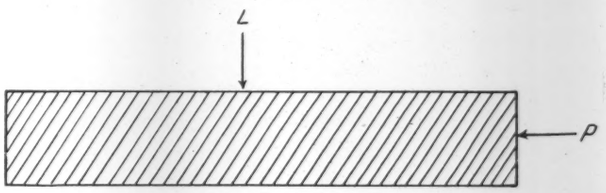
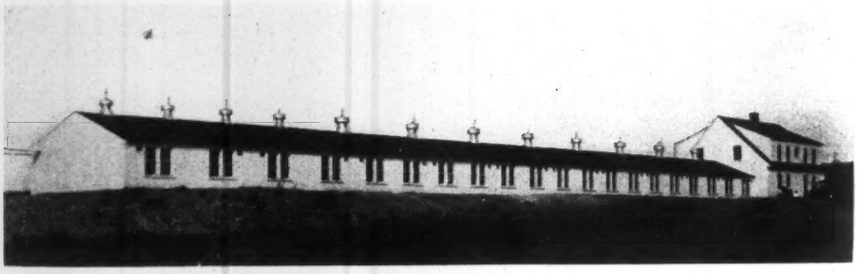


FIG. 4—ILLUSTRATING THE EXAMPLE ON DESIGNING A COPPER GASKET

A Poultry Plant Which Is Equipped With a Heating and Ventilating System



Heated and Ventilated Poultry Houses Have Many Advantages

By Frederic L. Campbell

THERE are three essentials to creating the proper environment in which poultry will respond to the maximum return per bird for the capital invested. These are a properly constructed and insulated house, a ventilating system and a means of heating. One without the other is hardly practical, though climatic conditions in various parts of the country must be taken into consideration.

In one installation fresh air from the outside comes in through louvres at the top and front of the house and is conducted through a flue to the proper distance inside. Here it slowly falls to the floor and spreads to all parts of the pen. As it gradually warms, it rises and following the insulated walls, reaches the outlet, carrying with it the excessive moisture prevailing in the house.

Tests were made on this system. Light charges of flashlight powder were exploded close to the floor and required one minute and 47 seconds for the noticeable particles of smoke to leave the room. This experiment was conducted with an inside temperature of 48 F, outside temperature of 18 F, and all windows and doors closed.

"Hen comfort" is about 48 F and it is at this temperature that the hen produces her maximum. Let the thermometer drop much below this mark and a slump occurs in egg production. If artificial heat is not supplied, extra feed must be given the birds to maintain the body temperature.

A bulletin issued by the *State Institute of Applied Agriculture,* Farmingdale, Long Island, New York, says: "The installation of artificial heat provided by a hot water system in the pens of the New York State Egg Laying Contest has proved very satisfactory from the standpoint of such observations as it has been possible to make. Based upon the maximum number of birds which a commercial poultryman could house in the floor space available, the cost of fuel for 190 days was 15.7 cents per bird. The price of coal was $15.00 per ton. It seems reasonable to expect from this a reduction in consumption of hard grain due to the air being heated.

"The average grain consumption during the five winter months, November to March inclusive, over a three-year period without heat was 21.4 lb. per bird, while with heat, feed records for the same months show 15.5 lb. of grain per bird. Based upon the average price of the grain formula there is a saving in feed cost alone of 13.6 cents per bird which almost equals cost of coal.

"Other charges to be included are the interest on the investment at 3.4 cents per bird; repairs and depreciation at 2 cents per bird and labor for the care of boiler ½ hr. each day at 1.6 cents per bird. At the average value of eggs it was computed that 10 eggs per bird increase would cover all the charges. It is doubtful if a poultryman would find it necessary to pay for additional labor for firing the boiler and removal of the ashes beyond the labor already available.

"If the saving in feed can be made to cover cost of fuel, then other conveniences obtainable would more than cover necessary minor charges and any increase in production would be clear gain. Some of the conveniences are uniform temperature, no windy corners, dryer litter, less frequent cleaning, no special egg collections in freezing weather, no frosted combs, no removal of ice from water pans, no problem of giving the birds drinking water at 4 a. m. in winter when the lights are used, no cost of operating water heaters and increased activity of the birds during early morning hours."

Almost any type of house can be remodeled to give satisfaction from the stand-point of ventilation and heating, the cost of equipment being in proportion to the size of the house. With increased egg production there follows a natural lowering of the hen's vitality and greater care must be given the poultry when adverse weather conditions prevail.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

MARCH 1932

Material in this Section prepared by Publication Committee: F. D. Mensing, *Chairman;* E. O. Eastwood and F. E. Giesecke
A. V. Hutchinson, Manager of Publications

Table of Contents

Room Warming by Radiation, by Arthur H. Barker.....207
Proceedings of the 38th Annual Meeting.....215
Second International Heating and Ventilating Exposition...234
F. Paul Anderson Medal Awarded to W. H. Carrier.....240
Entertainment at Cleveland Meeting.....241
Local Chapter Reports.....243
Candidates for Membership.....245
Candidates Elected.....245

OFFICERS AND COUNCIL 1932

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
51 Madison Ave., New York, N. Y.

President.....F. B. ROWLEY
First Vice-President.....W. T. JONES
Second Vice-President.....C. V. HAYNES
Treasurer.....F. D. MENSING
Secretary.....A. V. HUTCHINSON
Technical Secretary.....PAUL D. CLOSE

COUNCIL

F. B. ROWLEY, *Chairman* — W. T. JONES, *Vice-Chairman*

One Year
D. S. BOYDEN, R. H. CARPENTER, W. H. CARRIER, J. D. CASSELL, JOHN HOWATT

Two Years
E. K. CAMPBELL, E. O. EASTWOOD, ROSWELL FARNHAM, E. HOLT GURNEY

Three Years
F. E. GIESECKE, G. L. LARSON, J. F. McINTIRE, W. E. STARK

COMMITTEES OF THE COUNCIL

Executive: W. T. JONES, *Chairman*
W. H. CARRIER, E. HOLT GURNEY

Finance: JOHN HOWATT, *Chairman*
R. H. CARPENTER, W. T. JONES

Membership: ROSWELL FARNHAM, *Chairman*
J. D. CASSELL, W. E. STARK

Publication: F. D. MENSING, *Chairman*
E. O. EASTWOOD, F. E. GIESECKE

ADVISORY COUNCIL

W. H. Carrier, *Chairman;* Homer Addams, F. Paul Anderson, R. P. Bolton, S. E. Dibble, W. H. Driscoll, H. P. Gant, John F. Hale, L. A. Harding, H. M. Hart, E. Vernon Hill, J. D. Hoffman, S. A. Jellett, D. D. Kimball, S. R. Lewis, Thornton Lewis, J. I. Lyle, J. R. McColl, D. M. Quay, C. L. Riley, F. R. Still and A. C. Willard.

COOPERATING COMMITTEES

A. S. H. V. E. representative on *National Research Council:* Prof. A. C. Willard (3 years).

SPECIAL COMMITTEES

Committee on Chapter Relations: E. K. Campbell, *Chairman;* Roswell Farnham, and J. F. McIntire.

Committee on Code for Testing and Rating Concealed Gravity Type Radiation: R. N. Trane, *Chairman;* E. H. Beling, J. H. Holton, Hugo Hutzel, A. P. Kratz, J. F. McIntire, M. G. Steele and O. G. Wendel.

Committee on Code for Testing and Rating Condensation and Vacuum Pumps: John Howatt, *Chairman;* W. H. Driscoll, R. E. Gilmore, L. A. Harding and H. C. Meyer, Jr.

Committee on Meetings Program: A. P. Kratz, *Chairman;* L. A. Harding and C. V. Haynes.

Committee on Revision of Constitution and By-Laws: W. T. Jones, *Chairman;* and Thornton Lewis.

Committee on Ventilation Standards: W. H. Driscoll, *Chairman;* J. J. Aeberly, F. Paul Anderson, L. A. Harding, D. D. Kimball, J. R. McColl, C. L. Riley, W. A. Rowe, Perry West and A. C. Willard.

Guide Publication Committee: D. S. Boyden, *Chairman;* E. O. Eastwood, W. L. Fleisher, S. R. Lewis and Perry West.

NOMINATING COMMITTEE FOR 1932

Chapters	*Representative*	*Alternate*
Cleveland	C. F. Eveleth	F. A. Kitchen
Illinois	H. M. Hart	S. R. Lewis
Kansas City	Benjamin Natkin	
Massachusetts	C. P. Yaglou	J. W. Brinton
Michigan	G. D. Winans	W. G. Boales
Western Michigan	S. H. Downs	J. J. Troske
Minnesota	C. E. Lewis	A. J. Huch
New York	E. J. Ritchie	T. M. Kellogg
Western New York	Joseph Davis	D. J. Mahoney
Ontario	W. G. Sheppard	A. S. Leitch
Philadelphia	M. F. Blankin	A. C. Edgar
Pittsburgh	F. C. McIntosh	T. M. Dugan
St. Louis	C. A. Pickett	F. J. McMorran
Southern California	L. H. Polderman	R. L. Gifford
Wisconsin	J. G. Shodron	Ernest Szekely

COMMITTEE ON RESEARCH

G. L. LARSON, *Chairman*

PERRY WEST, *Vice-Chairman* — PROF. A. C. WILLARD, *Technical Adviser* — F. C. HOUGHTEN, *Director*

O. P. HOOD, *Ex-Officio Member*

One Year

C. V. HAYNES, W. T. JONES, J. F. MCINTIRE, F. N. SPELLER, PERRY WEST

Two Years

C. A. BOOTH, F. B. HOWELL, WALTER KLIE, F. B. ROWLEY, J. H. WALKER

Three Years

D. E. FRENCH, F. E. GIESECKE, A. P. KRATZ, G. L. LARSON, L. A. HARDING

Executive Committee

G. L. LARSON, *Chairman*

J. F. MCINTIRE — W. T. JONES

TECHNICAL ADVISORY COMMITTEES - 1932-1933

Air Conditions and Their Relation to Living Comfort: C. P. Yaglou, *Chairman;* I. C. Baker, W. L. Fleisher, D. E. French, Dr. E. V. Hill and Dr. R. R. Sayers.

Air Flow Through Registers and Grilles: John Howatt, *Chairman;* J. J. Aeberly, C. A. Booth, L. E. Davies, D. E. French and J. J. Haines.

Atmospheric Dust and Air Cleaning Devices (Including Dust and Smoke): H. C. Murphy, *Chairman;* J. J. Aeberly, Albert Buenger, Philip Drinker, Dr. E. V. Hill, H. B. Meller, Games Slaytor, Perry West and Dr. S. W. Wynne.

Correlating Thermal Research: R. M. Conner, *Chairman;* D. S. Boyden, P. D. Close, J. C. Fitts, W. T. Jones, H. T. Richardson and Perry West.

Gas Heating Equipment: W. E. Stark, *Chairman;* R. M. Conner, Robert Harper, F. B. Howell, E. A. Jones, Thomson King, Henry Loebell, J. F. McIntire, L. S. Ourusoff and H. L. Whitelaw.

Heat Transmission (Heat received by and emitted by buildings, in relation to living comfort): L. A. Harding, *Chairman;* A. B. Algren, R. E. Backstrom, A. H. Barker, A. E. Stacey, Jr., R. R. Seeber and J. H. Walker.

Infiltration in Buildings: J. G. Shodron, *Chairman;* J. E. Emswiler, F. E. Giesecke, D. W. Nelson, W. C. Randall, W. A. Rowe, Ernest Szekely, J. H. Walker and M. S. Wunderlich.

Oil Burning Devices: H. F. Tapp, *Chairman;* P. E. Fansler, R. V. Frost, F. B. Howell, R. C. Morgan and L. E. Seeley.

Pipe and Tubing (Sizes) Carrying Low Pressure Steam or Hot Water: S. R. Lewis, *Chairman;* J. C. Fitts, F. E. Giesecke, H. M. Hart, C. A. Hill, A. P. Kratz and W. K. Simpson.

Direct and Indirect Radiation with Gravity Air Circulation: H. F. Hutzel, *Chairman;* R. M. Conner, R. E. Daly, R. V. Frost, J. H. Holton, A. P. Kratz and J. F. McIntire.

Sound in Relation to Heating and Ventilation: Warren Ewald, *Chairman;* C. A. Booth, Carl Ashley, V. O. Knudsen, R. F. Norris, J. P. Reis and G. T. Stanton.

Ventilation of Garages and Bus Terminals: E. K. Campbell, *Chairman;* D. S. Boyden, H. P. Gant, Verne Hunter, W. C. Randall and A. H. Sluss.

OFFICERS OF LOCAL CHAPTERS 1932-33

CLEVELAND

Headquarters, Cleveland

Meets: Second Friday in Month

President, W. E. STARK
1875 Rosemont Rd.

Secretary, R. G. DAVIS
400—The Ninth—Vincent Bldg.

ILLINOIS

Headquarters, Chicago

Meets: Second Monday in Month

President, J. J. AEBERLY
704 City Hall

Secretary, C. W. DELAND
211 N. Desplaines St.

KANSAS CITY

Headquarters, Kansas City, Mo.

Meets: Second Monday in Month

President, J. M. ARTHUR
1330 Grand Ave.

Secretary, D. D. ZINK
1423 Baltimore Ave.

MASSACHUSETTS

Headquarters, Boston

Meets: First Monday in Month

President, DAVID MOULTON
99 Chauncey St.

Secretary, LESLIE CLOUGH
80 Boylston St.

MICHIGAN

Headquarters, Detroit

Meets: First Monday after the 10th of the Month

President, G. H. GIGUERE
13002 Greiner Ave.

Secretary, G. D. WINANS
2000 Second Ave.

WESTERN MICHIGAN

Headquarters, Grand Rapids

Meets: Second Monday in Month

President, O. D. MARSHALL
514 Anderson Bldg.

Secretary, C. H. ALEXANDER
313 Allen St.

MINNESOTA

Headquarters, Minneapolis

Meets: Second Monday in Month

President, H. E. GERRISH
808 LaSalle St.

Secretary, A. B. ALGREN
3049 10th Ave., So.

NEW YORK

Headquarters, New York

Meets: Third Monday in Month

President, RUSSELL DONNELLY
Graybar Bldg.

Secretary, W. A. SWAIN
80 White St.

WESTERN NEW YORK

Headquarters, Buffalo

Meets: Second Monday in Month

President, M. C. BEMAN
374 Delaware Ave.

Secretary, W. E. VOISINET
304 Curtiss Bldg.

ONTARIO

Headquarters, Toronto, Can.

Meets: First Monday Every Other Month

President, H. S. MOORE
23 River St.

Secretary, H. R. ROTH
1104 Bay St.

PACIFIC NORTHWEST

Headquarters, Seattle, Wash.

Meets: Second Thursday in Month

President, W. E. BEGGS
3639 Palatine Ave.

Secretary, M. ANDERSON
2467 Westmont Way

PHILADELPHIA

Headquarters, Philadelphia

Meets: Second Thursday in Month

President, L. C. DAVIDSON
810 Land Title Bldg.

Secretary, W. P. CULBERT
2019 Rittenhouse St.

PITTSBURGH

Headquarters, Pittsburgh

Meets: First Monday in Month

President, R. B. STANGER
Empire Bldg.

Secretary, J. L. BLACKSHAW
3752 Beechwood Blvd.

ST. LOUIS

Headquarters, St. Louis

Meets: First Wednesday in Month

President, J. M. FOSTER
4526 Olive St.

Secretary, C. R. DAVIS
2328 Locust St.

SOUTHERN CALIFORNIA

Headquarters, Los Angeles

Meets: First Tuesday after the 10th of the Month

President, F. R. WINCH
1031 S. Broadway

Secretary, E. H. KENDALL
1224 S. San Pedro St.

WISCONSIN

Headquarters, Milwaukee

Meets: Third Monday in Month

President, E. A. JONES
197 Reed St.

Secretary, H. F. HAUPT
170 Beaumont Ave.

Room Warming by Radiation

By Arthur H. Barker[1], London, England
MEMBER

IN ENGLAND radiant heating is regarded by many as superior to convection heating for five principal reasons:

1. It is more comfortable
2. It is hygienically superior
3. It reduces the fuel consumption
4. The heating surface is either invisible or inconspicuous
5. Comfortable conditions are rapidly reached

Room warming by low temperature radiation has not been extensively adopted in America although the principle appears to be equally as applicable to American conditions as to the much milder climate in England, of course, with suitable modifications of practice. Much more severe cold spells have to be provided against and much lower humidities generally prevail in America than in England, so that the capacity of the apparatus must be greater.

The valuable researches conducted by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS have shown the relation between the humidity and the temperature necessary for comfort. It is proved that where the method of heating by convection is adopted the air temperature must be maintained generally higher for an equal degree of comfort. Similar researches are needed on the extent to which a rise of radiant temperature will allow of a reduction in air temperature.

The principal feature of radiant heating is that it raises the air temperature *less* than other methods. It might therefore appear that in this respect it is less inherently suitable for a very cold than for a mild climate. This, however, will be seen to be a fallacy when the true principles of the method are considered.

Another reason may perhaps be that the fundamental principles are not easy to understand or to grasp, so much so that many people find difficulty in believing that there is any reality in radiant heating. It is one of the objects of this paper to present these principles in such a way that a person interested can not only appreciate this reality but make the necessary calculations from first principles.

Possibly one reason the development has taken place chiefly in England has been that the principle was first introduced into that country by the author, and it was there adopted by a very enterprising and able firm of heating engineers who devoted a large part of their resources to its development, and in its initial stages took some rather terrifying risks. On a small scale or in a laboratory the real difficulties that arise in a large installation are never revealed. No new system can be tried out effectively, except in several full-sized installations under normal operating conditions, and the essential defects may possibly not be revealed for many years after the plant has been in service.

Thus, in the case of the panel system of radiant heating, as originally introduced, the pipes were embodied permanently and immovably in concrete, and pipes so installed are liable after a period of use, to some dangers. These include the following, which might make the use of the whole apparatus impossible or call for extensive alterations or repairs:

1. Fracture from unequal expansion.
2. Corrosion, either internal or external.
3. Stoppage of the pipes.
4. Settlement of the structure to which most buildings are liable which might cause airlock.
5. The heat from the embedded pipes might cause extensive cracking of the plaster.

The contractor supplying such an installation has to take these very formidable risks. If he has conducted experiments in several large installations he might easily be ruined, if serious defects were to develop in all of them.

Physiological Considerations

The opinion has been commonly expressed that heat comfort depends almost entirely on the heat generated in the body being naturally dispersed from the surface when maintained at its normal temperature, so that the body temperature remains constant. The rate of heat production depends on the degree of muscular activity at the time, and the rate of dissipation on the surrounding conditions. Thus there are different rates of necessary heat loss from the body, according to the state of activity. Within certain limits nature provides for the variations by certain thermostatic adjustments of the body mechanisms.

Heat is lost from any warm body partly by radiation and partly by convection. The amount lost by convection in still air at a constant temperature depends solely on the temperature of the surrounding air, which would be shown by a thermometer suspended in the air with its bulb shielded from all radiation.

That lost by radiation depends not on the air at all but on the mean temperature of the surrounding surfaces, that is, on what the author has called the *mean radiant* temperature which would be shown by the reading of a thermometer suspended in the middle of a room, if all the air in the room could be abstracted so that the temperature of the surrounding air had no effect on the thermometer bulb. The technics of radiant heating require that these two considerations be dealt with separately.

When the *radiant* and the *air* temperature are the same, that is called the (British) effective temperature[2]

[1] Consulting Engineer.

Presented at the 38th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Cleveland, Ohio, January, 1932.

[2] The (*British*) *effective temperature* is not the same as *effective temperature* as defined by the Society.

which determines the *total* rate of heat loss by radiation and convection combined from any body at a temperature higher than that of the air. Fig. 1 shows the relation between the British effective temperature and the rate of heat loss from the body as determined by Mr. Dufton of the British Building Research Station[3]. The

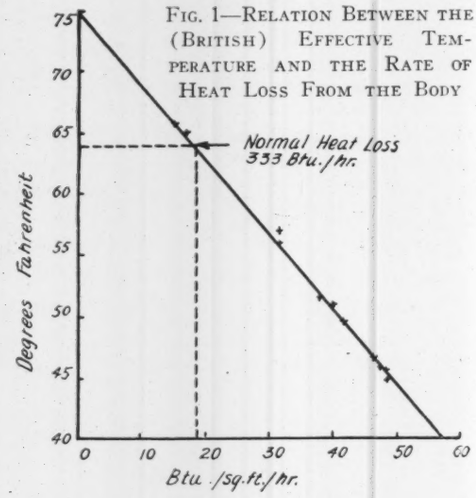


FIG. 1—RELATION BETWEEN THE (BRITISH) EFFECTIVE TEMPERATURE AND THE RATE OF HEAT LOSS FROM THE BODY

average surface temperature of the body including the clothes is taken as 75 F.

Thus in every warmed room there are three temperatures to consider. Generally the *radiant*, the *effective* and the *air* temperatures are all different, the *effective* being always between the other two. In a room heated by radiation the radiant is always higher than the air temperature and when heated by convection the air is always higher than the radiant temperature.

It has been in the past commonly believed or assumed that the degree of comfort depends solely on the rate of heat lost from the body irrespective of the method by which it is emitted. It is now generally accepted in England that there is a substantial difference in the feeling of comfort at the same total rate according to the way in which heat is abstracted. The higher the radiant and the lower the air temperature, the greater is the feeling of freshness for the same rate of heat loss.

Thus, if the walls of a room were uniformly at 75 F, no heat would be lost by radiation[4]. In order to maintain the body comfort the air temperature would have to be about 44 F so that the whole of the heat required to be abstracted from the body at 75 F should be removed by convection currents. Similarly, if the air of the room were at 75 F, no heat would be removed by convection and the surrounding walls would have to be at an average of about 50 F in order that the whole of the surplus body heat might be dissipated by radiation alone. The former condition would produce a feeling of warmth and freshness. The latter would feel equally warm but stuffy. The thermometer reading in the two cases would be widely different though the feeling of warmth would be the same.

The feeling of comfort in a room warmed by radiation is greater, the air feels fresher, and the conditions are often more desirable than with a room heated by convection. For example, in one of the large English public schools, Epsom College, in which there are two rooms side by side, one being a lecture room warmed by radiation panels, and the other a preparation room (in which the schoolboys study) which is warmed by convection, both of which are heated to the same (British) effective temperature, it is found that the boys always crowd into the lecture room to do their studies, because it makes them feel brisker and less sleepy, and that is precisely the difference in effect.

Operation of Radiant System

The practical problem of radiant heating has as its primary object the maintenance of the proper radiant temperature rather than the air temperature of a room. A progressive rise in the air temperature follows as a secondary effect. With a convective heating unit, the heating of the air is the primary effect, and the raising of the radiant temperature is a gradual process due to the warming of the walls by slow convection of the heated air circulating over the wall surfaces. Probably one of the principal reasons why air temperatures in America are so much higher than in England is to compensate for the lower temperature of the walls.

Radiant heat from a panel travels over the room instantaneously. All the heat delivered by the panel as radiant heat is at once distributed principally in the center of the room and absorbed by the floor, ceiling and walls. As the reflecting power of such surfaces never exceeds from 5 to 10 per cent, it follows that 90 or 95 per cent of the radiant heat impinging on the floor and walls is at once absorbed and this heat gradually raises the temperature of these surfaces and is slowly conducted through the walls. The surfaces of the walls therefore assume certain ultimate temperatures depending on their construction and exposure. The difficult part of the problem is to determine what these temperatures are. In practice they can only be determined by experience in connection with the particular climate concerned, as the necessary calculations would be far too involved for practical use.

The heat falling on carpets and furniture raises their temperature much more rapidly. This causes the warming of the surrounding air. The surfaces of the furniture near the panels will be found perceptibly warm.

Calculation of Heat Requirements

The calculation of the heat requirements is, therefore, quite different in principle from those usual for convective heating. Instead of calculating the heat lost by conduction through the walls, an endeavor is made to estimate the surface temperatures which the various parts will assume. If the surfaces are too cold they will absorb too much radiant heat from the body. By introducing a number of smaller surfaces maintained at a high temperature and disposed in suitable positions about the room, the negative radiation from the cold walls and windows is neutralized, and the mean radiant temperature is raised to the desired value. The problem, therefore, is first to find the value of the radiant temperature which would absorb a desirable amount of radiant heat from the body and then to determine a suitable amount of surface, maintained at a suitable temperature

[3] Dufton: The Effective Temperature of a Warmed Room (*Philosophical Magazine*, ix, p. 858, 1930).

[4] See Panel Warming, by L. J. Fowler (A. S. H. V. E. TRANSACTIONS, Vol. 36, 1930).

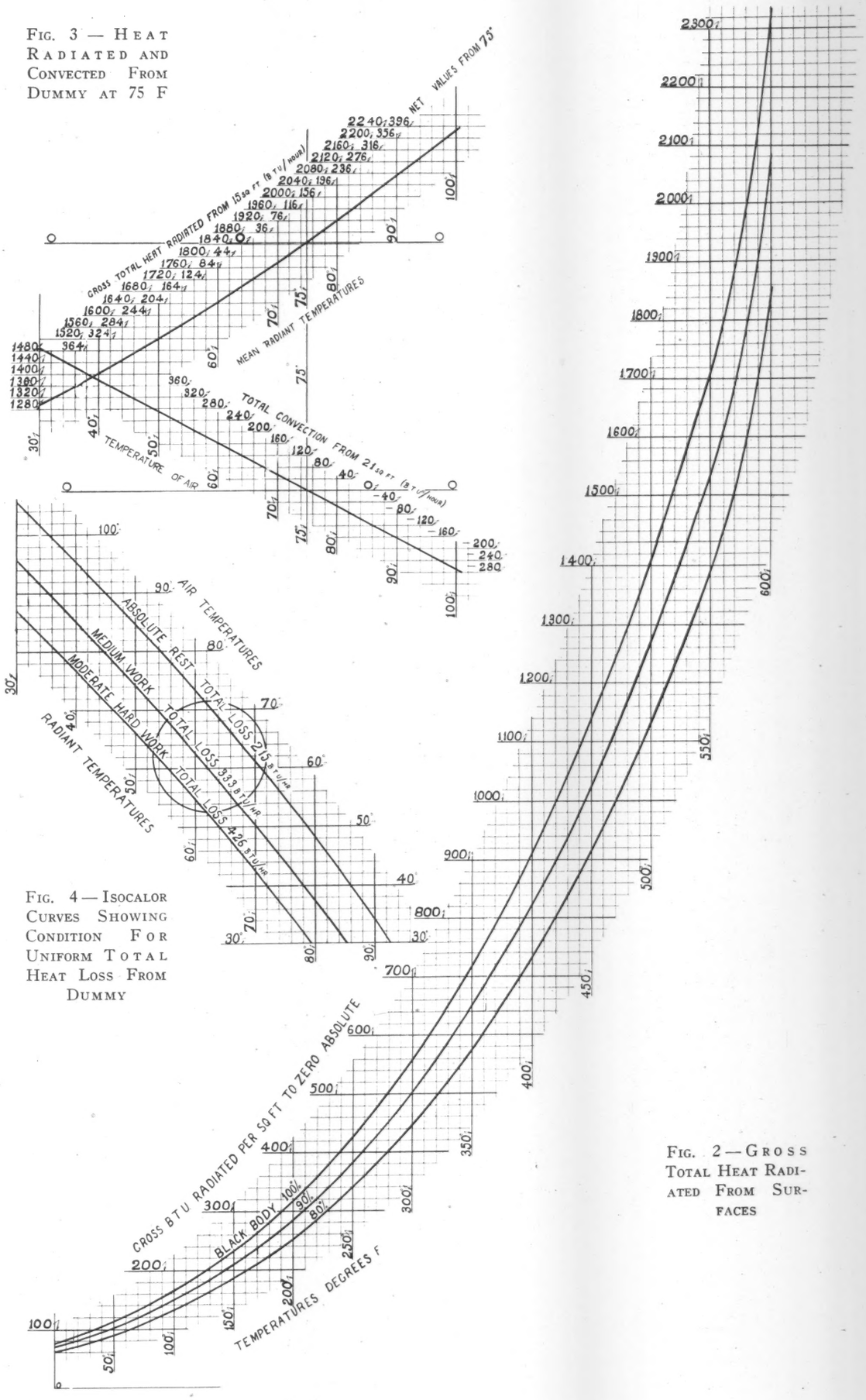


FIG. 3 — HEAT RADIATED AND CONVECTED FROM DUMMY AT 75 F

FIG. 4 — ISOCALOR CURVES SHOWING CONDITION FOR UNIFORM TOTAL HEAT LOSS FROM DUMMY

FIG. 2 — GROSS TOTAL HEAT RADIATED FROM SURFACES

and placed in suitable locations to raise the mean radiant temperature to that desired value.

The next step is to consider the loss of heat from the body. The amount given off as radiation by any body to an environment at absolute zero is given in Table 1 and shown graphically in Fig. 2. The second column of Table 1 shows the amount given off per square foot per hour from an absolute black body and the third the amount given off from a body having a surface radiativity of 90 per cent. The net amount given off or absorbed by any surface when completely enclosed in a chamber whose walls are at a different temperature is the difference between the amount which it itself emits at the higher and the lower temperatures respectively. Thus a body of 90 per cent radiativity at 75 F contained in an enclosure at 63 F would emit a net amount of heat of $123 - 112.2 = 10.8$ Btu per square foot per hour.

The human body is of varying size and shape due to its constant movement, and of varying temperature. It is therefore necessary to assume for purposes of calculation that it is represented by some solid object of geometrical form maintained at a constant temperature of which the fixed dimensions are known, and from which the amount of heat lost can be calculated. Complication arises from the fact that the surface for purposes of radiation is not the same as that for purposes of convection.

The whole of the outside surface loses heat by convection but a considerable area is protected from radiation by its re-entrant shape. Thus the areas between the legs, or under the arms, or between the head and the trunk and other parts radiate chiefly to one another and therefore, the amount of radiation from those portions is nullified or greatly reduced.

From calculations it has been estimated that in respect to radiation an average body may be represented by a cylinder having a diameter of 12 in. and an area of 15 sq ft, and for purposes of convection by a similar cylinder having a superficial area of 21 sq ft. (See Table 2.)

Heat Loss

Rubner's figures show that 333 Btu per hour are lost from a normal human body at ordinary sedentary work when maintained in a state of comfort. Of this total the same authority estimates that about 195 Btu are lost by radiation and 138 Btu by convection, presumably for the actual conditions of the room in which the experiments were made of which he gives no particulars.

If a body of 15 sq ft maintained at 75 F is to lose 195 Btu per hour by radiation,

$$\frac{195}{15} = 13 \text{ Btu per square foot per hour,}$$

the environment must have an emission of $123 - 13 = 110$ Btu per sq ft per hour, which corresponds to a mean radiant temperature of 60.5 F (see Table 1).

Similarly, if a cylinder having an area of 21 sq ft is to lose 138 Btu per hour or $\frac{138}{21} = 6.6$ Btu per square foot per hour, this corresponds to an air temperature of 63 F. It therefore appears from these figures that the problem is to raise the radiant temperature to 61 F and the air temperature to 63 F.

Example

The following example of a small room will illus-

TABLE 1—TOTAL RADIATION PER SQUARE FOOT

Temp	Total Black Body Radiation Btu per Sq Ft per Hour	Total Black Body Radiativity 0.9	Total Black Body Radiativity 0.8	Temp	Total Black Body Radiation Btu per Sq Ft per Hour	Total Black Body Radiativity 0.9	Total Black Body Radiativity 0.8
30	96.2	86.6	77	71	132.2	120.1	106
35	100.2	90	80	72	133.1	121.0	107
40	104.2	94	83.5	73	134.0	121.8	107.8
45	108.6	97.7	87	74	135.3	122.2	108.5
46	109.4	98.4	87.3	75	136.6	123	109
47	110.3	99.3	88.3	80	142	127.5	113.5
48	111.2	100.2	89	85	147.5	132.5	118
49	112.0	101	89.6	90	153	137.5	122
50	112.9	101.5	90.3	100	164.3	147	131.5
51	113.8	102.3	91	110	176.0	158	141
52	114.7	102.9	91.7	120	188.7	169.5	151
53	115.6	103.7	92.5	130	203.6	183	163
54	116.5	104.6	93.3	140	216.2	195	173
55	117.4	105.5	94	150	229.8	206	183
56	118.3	106.3	94.7	160	243.3	219	194
57	119.2	107.1	95.4	170	262	236	210
58	120.1	107.9	96.1	180	279	251	223
59	121	108.7	96.8	190	297	267	237
60	121.8	109.5	97.5	200	315	283	252
61	122.7	110.4	98.2	210	337	303	269
62	123.7	111.3	99	220	360	324	288
63	124.6	112.2	99.7	250	424	381	339
64	125.6	113.1	100.4	300	557	500	445
65	126.5	114	101.2	350	717	655	573
66	127.5	115	102	400	913	821	731
67	128.4	116	102.8	450	1140	1025	911
68	129.3	117	103.5	500	1418	1275	1133
69	130.3	118	104.3	550	1735	1560	1390
70	131.2	119	105	600	2330	2095	1865

TABLE 2—HEAT LOST PER HOUR BY CONVECTION FROM VERTICAL CYLINDER 12 IN. DIAMETER OF 21 SQ FT AREA MAINTAINED AT 75 F TO SURROUNDING AIR AT VARYING TEMPERATURES

Temp of Surrounding Air	Diff. From 75 F	Total Heat Lost by Convection Btu Per Hour	Temp of Surrounding Air	Diff. From 75 F	Total Heat Lost by Convection Btu Per Hour
30	−45	490	75	+ 0	−0
35	−40	432	76	+ 1	−11
40	−35	378	78	+ 3	−32
45	−30	324	80	+ 5	−54
50	−25	270	82	+ 7	−75
52	−23	248	84	+ 9	−97
54	−21	227	86	+11	−119
56	−19	205	88	+13	−140
58	−17	183	90	+15	−162
60	−15	162	92	+17	−183
62	−13	140	94	+19	−205
64	−11	119	96	+21	−227
66	− 9	97	98	+23	−248
68	− 7	75	100	+25	−270
70	− 5	54			
72	− 3	33			
74	− 1	11			
75	− 0	0			

TABLE 3—SURFACE AREAS, TEMPERATURES AND EMISSIONS FOR A ROOM OF 5760 CU FT

	AREA SQ FT	ASSUMED SURFACE TEMPERATURE (DEG FAHR)	HEAT EMISSION (BTU PER SQ FT PER HR)
External Wall	297	50	101.5
Glass	279	45	97.7
Inner Wall	480	55	105.5
Ceiling	480	55	105.5
Floor	480	55	105.5

trate the calculations for the radiant temperature. The figures given in Table 3 for the temperatures are appropriate for the English climate. Correspondingly lower figures would have to be determined for colder climatic conditions.

Calculations for mean radiant temperature (MRT):

$$\begin{aligned} 297 \times 101.5 &= 30{,}000 \\ 279 \times 97.7 &= 27{,}300 \\ 480 \times 105.5 &= 50{,}600 \\ 480 \times 105.5 &= 50{,}600 \\ 480 \times 105.5 &= 50{,}600 \end{aligned}$$

$$2016 \qquad 209{,}100$$

$$\text{Mean emission} = \frac{209{,}100}{2016} = 103.5 \text{ Btu per square foot}$$

Corresponding MRT = 53 F

If a body of 15 sq ft at a surface temperature of 75 F were put in this room the heat it would lose would be $15 \times (123 - 103.5) = 290$ Btu per hour, which is 95 Btu per hour or 6.35 Btu per square foot per hour too high.

In order to raise the MRT to 60.5 F proceed as follows:

Assume the surface temperature of the hot plate to be 200 F which corresponds to that of a steam heated metal plate as used with this type of heating system and which will be discussed later. The summation representing the room calculations instead of being 209,100 Btu should be $2016 \times 110 = 221{,}760$ Btu so it is necessary to increase the 209,100 Btu by 12,660 Btu. The emission per square foot at 200 F is seen to be 283 Btu. The required surface is therefore $\frac{12{,}660}{283} = 45$ sq. ft. If the surfaces are 30 in. wide the total length required is about 18 ft. The effect of this surface suitably disposed would be to raise immediately the radiant temperature to the required degree and to maintain it at that value as long as the surfaces remained at the values assumed.

It is necessary also to calculate how much heat will be given off by the same surfaces by convection and thereby to ascertain whether this amount of convected heat is adequate for warming the air corresponding to the degree of ventilation required. If it is not, then additional convection surfaces must be introduced to make up the balance.

One peculiarity of radiant heat is that it is practically used twice, once in maintaining the radiant temperature and once by what may be called secondary convection. Any heat falling on the furniture, carpets, or walls, thereby raises the temperature of their surfaces, and that heat is partly used in raising the temperature of the air which comes in contact with them. It is not possible to make any rational calculations of the amount of heat so communicated to the air, which depends among other things on the character and disposition of the furniture and on the conductivity of the walls. It appears that this factor can only be determined empirically and a good deal of observation and research is necessary in the climatic conditions concerned before any authoritative figures could be established.

Such is, briefly, the principle on which these calculations are made. It will be seen that it is possible to prepare a table which will give the amount of heating surface at high temperature which will compensate for a square foot of cold surface at a lower temperature, so that the calculations are very much simplified. Once the quantities are calculated in this way the ingenuity of the engineer must be exercised in order to find means for supporting the necessary panels in suitable positions.

Practical Aplications

The manner in which these principles may be carried out in practice offers a wide scope for ingenuity and invention. There are three main features of any method:

1. The character of the radiating surface which is to be kept hot.
2. The method of supporting it and its disposition.
3. The means of conveying heat to it.

In England the author has been responsible for most of these proposals. The first one consists of embedding coils of pipes in the concrete of the ceilings or the surface of the plaster and forcing hot water or in some cases steam through the coils. This has the effect of heating the whole of the plaster or concrete in contact with the pipes. This method has been successfully applied to at least two American buildings one of which is the British Embassy at Washington.

Sundry improvements have been made in England to the original method with the object of preventing or restricting the transmission of heat into the body of the concrete, and so raising the temperature of the plaster surface. This has been done in some cases by forming recesses in the concrete which are filled with insulating material, on which the pipes are laid, being later covered in by the plaster in various ways so that the pipes are not immovably embedded in the concrete.

Iron Plates

To accomplish the same purpose, metal plates have been extensively used in several different ways. The most favored method is by forming a radiator with a flat front face with shallow waterways cast on them at the back in which hot water or steam circulates or in which electric elements are fixed. These plates are made in sections and are nippled together just as is an ordinary radiator, leaving the front face flat. These surfaces are either attached direct to the face of the wall or ceiling, or in many cases installed in specially formed recesses, so as to present a uniform finished surface. There are several thousands of such installations in England, photographs of a few of which are shown in Figs. 5 to 10.

In some cases in order to increase the convection, and thereby the total heat output, a space is formed at the back of the metal plate so that air can circulate over both the front and the back face. Though this has the effect of reducing the cost of the plant and the necessary surface, it increases substantially the fuel consumption.

FIG. 5—LONDON GENERAL OMNIBUS FACTORY SHOWING METAL PLATES ON ROOF

Anything which tends to increase the amount of convection tends pro rata to increase the fuel consumption and to decrease the comfort. In some cases the flat surface of the metal plate has been covered with wall-paper or other decorative materials.

Veneers

Removable wood or composition panels are sometimes placed over the flat plate and these become warm by contact, special arrangements being made to prevent warping and other undesirable effects.

Floor Heating

A similar principle has also been used in England to a considerable extent in which all the heat is communicated to the floor. The most notable example of this is the new Liverpool Cathedral which is entirely heated in this way. It is also done in smaller buildings such as schools and churches, by covering the floor with removable precast slabs supported on dwarf walls, thus producing a series of channels under the floor. In these channels pipes, heated either by water or by electricity, are installed and, being insulated on the under side, communicate a large part of the heat given off to the slabs immediately over. These are raised to about 70 F and the effect is very pleasing; a feeling of warmth and comfort is produced even though the surrounding air is quite cold.

Heating Media

The media by which the heat is conveyed to the plate are as follows:

1. *Steam,* which is rarely used in England except in workshops and factories.
2. *Hot water,* which is circulated to the surfaces by centrifugal pumps.
3. *Electricity,* which is now extensively used in England for heating purposes.

There are more than 3,000 installations in England heated by electricity. This is done in several different ways. The most successful up to the present has been to use a specially-designed metal plate of the same general construction as has been described, with a specially-designed flexible electrical element in each of the pass-

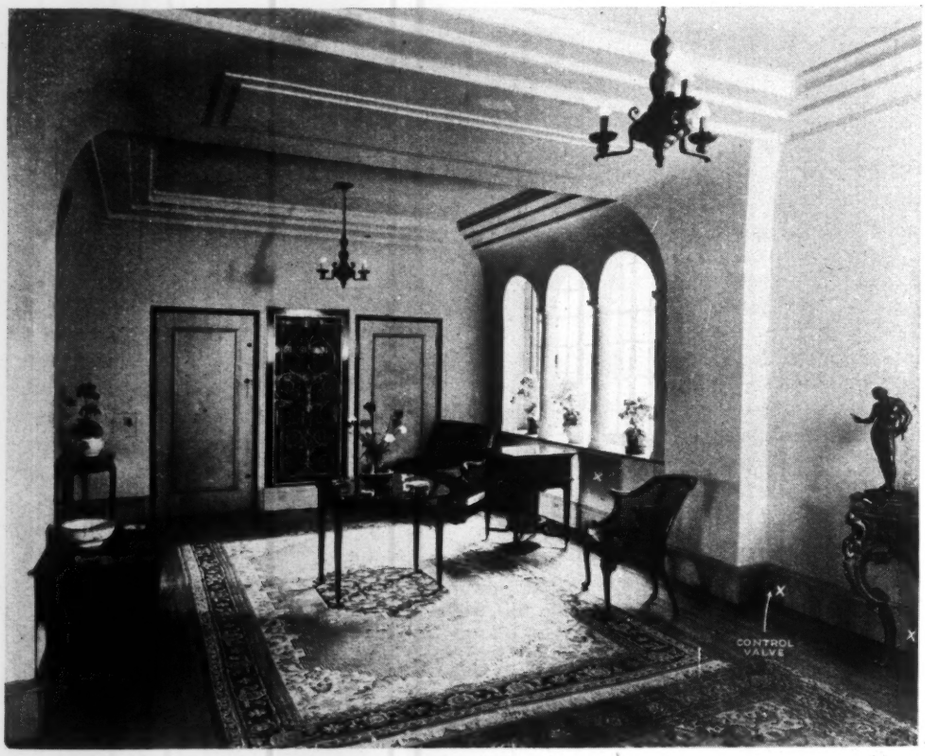


FIG. 6—ENTRANCE HALL IN PRIVATE HOUSE SHOWING METAL PLATES USED ORNAMENTALLY

ages. The heat from these elements rapidly communicates itself to the iron and spreads by conduction over the front surface. Such plates are usually applied to the ceiling as shown in Fig. 11, more rarely to the walls. In some cases they are installed as a continuous dado along the whole length of a room, as for instance, in a hospital ward. (See Fig. 7).

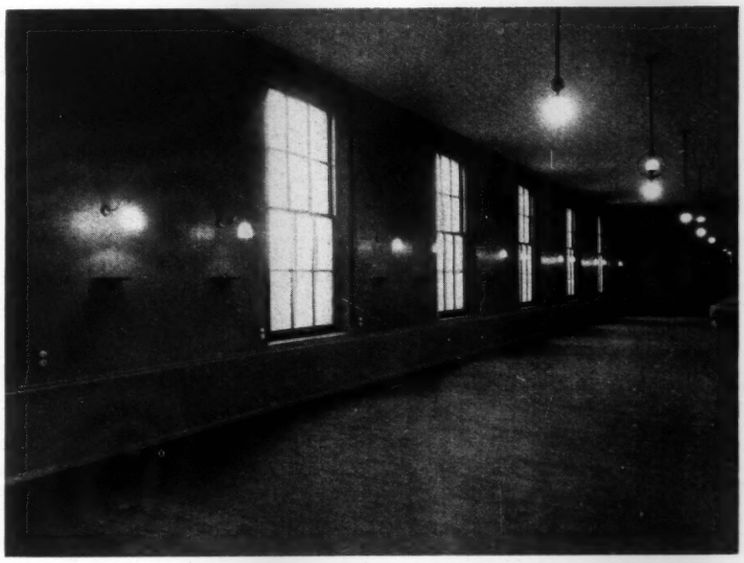


FIG. 7—HOSPITAL WARD SHOWING METAL PLATES AS DADO

Fig. 9 shows a similar arrangement in which a dado is formed along a drawing office. This particular case is the property of an American firm which has established a branch in England. Their initial requirements called for a maintained temperature of 75 F. When it was explained to the clients that in England such a temperature would be altogether excessive and intolerable, they consented, under protest, to reducing the demands to 70 F, to which value the calculations were made. When the apparatus was first put into use two years ago it was found that any air temperature approaching 70 F was far too high and instructions were given that it be reduced by maintaining a temperature of the water leaving the boiler of 120 F, at which temperature the interior of the room is maintained in cold weather at about 65 F, which is found to be as high as can be endured.

Another method which has attained wide use in England is a pottery panel in which an electrical heating element is incorporated, the whole being cast in one solid block. The heating element consists of a graphite grid connected to two conductors on the outside of the panel. These can be raised to a fairly high temperature, about 500 F, and are located in the corners and on the walls of a room from which they radiate their heat into the room interior. This is a very inexpensive method of carrying out this principle.

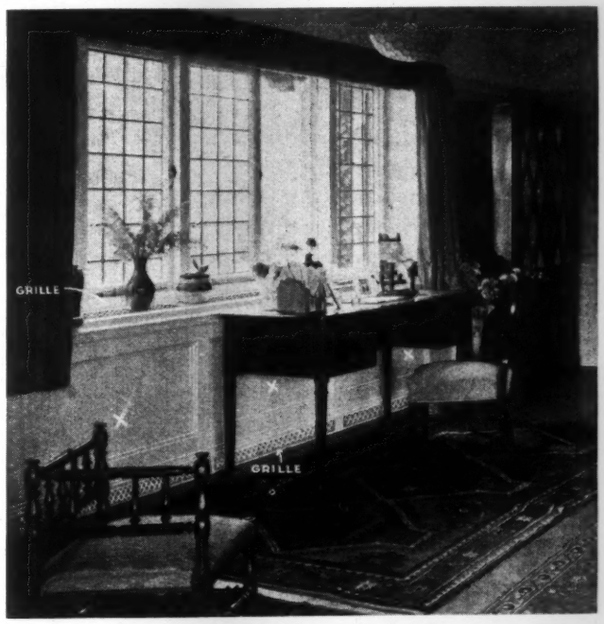


FIG. 8—SHOWROOM ILLUSTRATING METAL PLATES COVERED WITH VENEER

All these panels are controlled by thermostats such that when the radiant temperature in the room reaches a pre-determined value the panels are automatically switched off one at a time so that the temperature is maintained uniform, and no more electrical power is used than is necessary for the purpose. It is found that a building can be heated in accordance with the requirements of the English climate throughout an entire winter season, for an expenditure of electrical energy equal to about one kilowatt hour per cubic foot of space heated, and for less than half this expenditure for buildings such as schools or churches which are not continuously in use.

This method has useful application in

FIG. 9—DRAWING OFFICE OF AMERICAN FIRM IN LONDON HEATED WITH METAL PLATES

FIG. 10—HOSPITAL WARD WITH METAL PLATES ON CEILING

churches and in similar buildings in which the conditions can be localized, so that the people sitting in the seats are kept warm without warming the rest of the building. In these cases electrically heated tubes are installed under the seats, and in some cases pottery panels are fixed in such positions as to radiate downwards on the bodies of the congregation.

Comfortable conditions can thus be established even on a very cold day by switching on the electrical power about two hours before the congregation is due to assemble. It is found that even with the high cost per Btu of electrical power, as compared with coke, the total annual cost of heating a church in this manner is considerably less than heating by coke. Electrical energy is supplied for the purpose at one cent per kilowatt hour. The most desirable method of heating a building by electrical power involves a combination of all these three methods, and much experience has accumulated in England on this subject.

In England there is a greatly increased use of this method in what are called open air schools, which are schools with wide opening windows on each side, and in all ordinary weather these are kept wide open, so that there is a very free passage of air through the classrooms. In these conditions the heat can only be delivered by radiation, as all convected heat would at once be blown away.

Gas

The author has also made attempts to carry out the same principle by heating radiating panels locally by a small gas jet. The products of combustion in this case are drawn through the passage and off the outlet by means of a small centrifugal fan, located in the basement, or in any other suitable position. A system of copper pipes is carried from the outlet to the fan and the diameters are so calculated as to maintain a suction of about ½ in. of water at the outlet of each of the metal plates. The effect is very good and the economy in gas is considerable. It is found that not more than half as much gas is required for heating a building in this way as by a system of gas-heated radiators in which the products of combustion are allowed to escape into the room. The latter system has some vogue in Great Britain, though it is not one which some of us would recommend on account of the undesirable introduction into the air of the room of the products of combustion and much water vapor, but in some situations it is found reasonably satisfactory in England.

FIG. 11—RANGE OF OFFICES SHOWING ELECTRICALLY HEATED METAL PLATES ON CEILING

Proceedings of the 38th Annual Meeting

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Cleveland, Ohio, January 26 to 29, 1932

A BUSINESS session at which it was revealed that the Society came through 1931 in excellent financial condition, two joint sessions with the *American Society of Refrigerating Engineers* at which papers of unusual practical and scientific value were presented, and a *code* session at which the reports of two important committees were presented, namely, the Committee on Code for Testing and Rating Unit Ventilators, and the Committee on Ventilation Standards—these were the high lights of the 38th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, held in Cleveland, Ohio, January 26-29, 1932.

The registration of the 725 members and guests was held in the Hotel Statler as were the technical sessions—with the exception of the two joint sessions with the *American Society of Refrigerating Engineers,* at the Little Theatre.

In addition to the two important code committee reports in which widespread interest was evident, 15 scientific and technical papers were presented at the six sessions. These included 9 papers resulting from research conducted at the A. S. H. V. E. Laboratory at Pittsburgh, and at institutions with which the Society maintains co-operative agreements.

Council meetings were held on Monday, January 25, and Friday, January 29, and research meetings were held on Monday, January 25, and Wednesday, January 27. Other special meetings held prior to and during the sessions included those of the Finance Committee, Chapter Relations Committee, Nominating Committee, Committee on Code for Testing and Rating Concealed Gravity Type Radiation, Committee on Ventilation Standards, and Technical Advisory Committee on Radiation.

First Session—Tuesday, January 26—9:30 A. M.

The 38th Annual Meeting was called to order by Pres. W. H. Carrier, and W. E. Stark, president of the Cleveland Chapter, made the address of welcome.

In President Carrier's response, he expressed appreciation for the work of the various committees of the Cleveland Chapter which had made the arrangements for the meeting.

President Carrier then read the report of the Council and in this connection stated that Secretary Hutchinson had taken the initiative in endeavoring to render aid to members of the Society who were out of employment, and in some cases, in distress.

Report of the Council

Meetings of the Council were held in January, April, June and November, 1931, and January, 1932, and all business matters prescribed in the Constitution and By-Laws were acted upon.

The organization meeting was held in Pittsburgh, Pa., January 29, 1931 with President W. H. Carrier presiding and standing and special committee appointments were announced and depositories for Society funds were selected.

On April 13, the Council met in Chicago, Ill., and formally adopted the Budget for 1931 and approved the program for the Semi-Annual Meeting at Swampscott.

The idea of quarterly publication of TRANSACTIONS was considered and referred to the Publication Committee for study and recommendation.

At the Semi-Annual Meeting at Swampscott two Council meetings were held. The invitation of the Wisconsin Chapter to have the Semi-Annual Meeting 1932 was accepted during the week of June 27th. The matter of amending the Society's Constitution and By-Laws was discussed in detail and it was also recommended that the rules for procedure prepared by a special committee be referred to the Committee on Revision of the Constitution with a suggestion that the rules be made an appendix to the Constitution and By-Laws.

Nominees for membership on the Committee on Research were made. A Committee on Award for the F. Paul Anderson Medal was announced and members of the Society were invited to submit the names of nominees for the award.

The idea of a co-operative program to obtain speakers for several chapters was proposed by the Chapter Relations Committee and approved.

At a special meeting of the Council, the budget of the Committee on Research was approved, and Perry West was designated to serve as a member of the Committee on Research in place of Prof. A. C. Willard.

The idea of continuing to publish the JOURNAL as a section of *Heating, Piping and Air Conditioning* was thoroughly discussed and the matter was referred to the Committee who originally negotiated the contract, with power to make the best possible terms. An agreement for a five year period was prepared and signed.

In Buffalo, November 9, the Council granted the petition of the Western Michigan members for a Chapter at Grand Rapids; received the report of the Anderson Medal Committee, and approved the program for the Annual Meeting 1932. Reports from various special committees were received including the proposed Code for Testing and Rating Unit Ventilators; the revised contract for publishing the JOURNAL; the quarterly publication of TRANSACTIONS and the publication of THE GUIDE.

At all meetings, the matter of relief for members affected by economic conditions was a matter of serious discussion and every encouragement was given to men whose dues were in arrears, to continue their membership.

Formal action was taken in granting life membership to 13 men, reinstatement of 13 men, and the acceptance of resignations of 74. Action was taken with regret in the case of 21 who failed to affiliate and 107 who where in arrears for dues.

The next report was that of the secretary which was read by Mr. Hutchinson.

Report of the Secretary

The Society has passed through the trying year 1931 with a record of many things accomplished, a slight increase in membership during the calendar year and with a good financial outlook for the beginning of the new year. The progress made during the fiscal year in handling a greatly increased volume of work without enlarging the staff, will give an indication of the splendid co-operation of my assistants who have so ably handled their assignments and have spent many extra hours on the job without additional compensation.

The various committees that have functioned during this year have handled their work with dispatch and the results of the progress of their deliberations will be reported at this meeting.

Some of the important actions taken during the year were the approval by the Society of two new Codes and the revision of one previously adopted:

1. Code for Testing Steam Boilers Burning Oil Fuel.
2. The Code for Testing and Rating Concealed Gravity Type Radiation.
3. Revision of Standard Code for Testing Centrifugal Blowers and Disc Fans.

Since the last Annual Meeting a special committee has compiled the Code for Testing and Rating Unit Ventilators to be presented here for consideration and a set of ventilation standards has been prepared by a special committee to meet the demands of modern requirements of various typs of buildings. Discussion of these two reports is to be scheduled at this meeting.

In the publication work the items of major importance were—

1. Production and distribution of THE GUIDE 1932.
2. Compilation of the TRANSACTIONS 1930 (ready for mailing).
3. Printing of the TRANSACTIONS INDEX for the years 1895 to 1930.
4. Reprinting and distribution of four standard codes previously adopted by the Society—
   a. Standard Code for Testing Solid Fuel Boilers.
   b. Performance Test Code for Boilers Burning Solid Fuel.
   c. Standard Code for Testing and Rating Steam Unit Heaters.
   d. Standard Code for Testing Heat Transmission of Building Materials.
5. Production of the booklet describing the research work of the Society.

An effort that has developed to one of major importance resulted from the employment survey made among 2,000 manufacturing, engineering and contracting firms with the object of keeping trained heating and ventilating engineers employed in their own specialized field. The plan developed was to obtain leads and refer them to members who were seeking new connections. Chapter representatives were assigned by the various local organizations to assist in locating the men who needed work so that proper leads and interviews might be arranged. Both direct-by-mail and direct advertising through the trade press is being used to assist the members. Some progress has been made in placing men in various parts of the country. There is still a long list of those who need assistance, particularly men who have specialized in design, layout and estimating.

The Council granted a Charter for the Western Michigan Chapter at Grand Rapids and this group formed a permanent organization after a preliminary meeting in October attended by the President, Secretary and Messrs. McColl, Rowe and McIntire of Detroit.

Each Chapter of the Society was visited by the President and Secretary during the year in the 16 cities where local organizations are functioning.

The present status of membership shows a total of 2,256, 2 honorary members, 1,539 members, 490 associates, 203 juniors and 22 students, an increase of 27 during the current year.

Report of the Treasurer

The report of the treasurer was submitted verbally by F. D. Mensing who stated that the financial returns for 1931 were satisfactory considering the circumstances. The returns for dues were slightly in excess of the previous year, whereas the returns for new members were slightly under the previous year. Mr. Mensing stated that the delinquent members were written to individually and the response was very satisfactory.

Report of the Finance Committee

The next report was that of F. C. McIntosh, chairman of the Finance Committee, who stated that there was a good profit from The Guide and a net loss on general Society operations of only $138, which he considered exceptionally good for the year 1931. Although the income from dues and miscellaneous sources was far under the budget and under what could be expected in normal times, Mr. McIntosh said, the Society was able to effect considerable savings in general expenses through the persistent effort of Secretary Hutchinson.

The cost of publishing the TRANSACTIONS, 1929 and 1930, exceeded estimates because of an unexpected increase in the amount of material that was included. The unpaid 1931 dues at the end of the year, according to Mr. McIntosh's report, amounted to $12,744 and the amount still due from prior years was $4,154. Mr. McIntosh pointed out that on account of the deferred action of the Council, the total membership was 27 greater on December 31, 1931, than it was the year before, although over 200 members have since been released either through resignation or non-payment. The net profit from THE GUIDE, which might be used for research, had been considerably reduced because of heavy reserves set up for bad debts.

President Carrier asked whether there were any questions regarding the treasurer's report or the financial condition of the Society. On motion of J. J. Aeberly, which was seconded by John Howatt, it was voted that the reports be accepted.

Report of Certified Public Accountant

FRANK G. TUSA
Certified Public Accountant
Audits—Tax Service—Systems
Italian Savings Bank Building
New York, N. Y.

January 8, 1932.

American Society of Heating and
Ventilating Engineers,
51 *Madison Avenue,*
New York City.

Gentlemen:

Pursuant to your request I made an examination of the books of account and records of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, New York City, for the year ended December 31, 1931 and submit herewith my report.

The work covered a verification of the Assets and Liabilities

as of the date previously stated and a review of the operating accounts for the calendar year 1931. For the aforementioned period, the recorded cash receipts were traced into the depositories; the cancelled bank vouchers were compared with the cash disbursement records; and membership dues were accounted for.

Submitted herewith is a Balance Sheet showing the financial condition of the Society on December 31, 1931 and your attention is directed to the following comments thereon:

CASH

Cash on Deposit was verified by direct communication with the banks listed below and by reconcilement of the amounts reported to me with the balances shown by the books of the Society.

Banks	*Amounts*
Chase National Bank (Special)	$ 39.63
Chase National Bank (Regular)	140.90
Bankers Trust Company	1,842.86
Bowery Savings Bank (Book No. 57,001)	642.63
Bank of United States in Liquidation	500.00
Total	$3,166.02

The petty cash on hand was counted and found correct.

MARKETABLE SECURITIES

There is attached hereto a schedule of negotiable bonds which were verified by direct communication with the Bankers Trust Company where same are deposited for safekeeping. No adjustment has been made of the $12,293.17 shrinkage in the market value of these securities. These have been included on the attached Balance Sheet at cost.

ACCOUNTS RECEIVABLE

Unpaid membership dues were determined by trial balance of the individual ledger cards and comparison of same with the Dues Register. A summary of them as to years charged is shown below:

1931 Unpaid Dues	$12,743.75
1930 Unpaid Dues	4,154.09
1929 Unpaid Dues	760.00
Total	$17,657.84

My verification of the dues disclosed that during the year 1931 there had been prepaid to the Society dues amounting to $206.75 which I have shown on the attached Balance Sheet as deferred income.

The Reserve found on the books to cover probable losses which may result from prior years' dues was found ample. In addition, however, I have provided the sum of $9,557.81 which is equivalent to seventy-five (75%) per cent of the unpaid 1931 dues. Adequate Reserves have also been provided to cover losses which may be incurred from the realization of all other accounts receivable.

BALANCE SHEET

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
NEW YORK CITY

December 31, 1931

ASSETS

SOCIETY				
CASH				
On Deposit		$ 3,166.02		
On Hand		100.00	$ 3,266.02	
INVESTMENTS (AT COST)				
Securities (Market Value $10,540.00)		12,919.49		
ADD: Accrued Interest		78.75	12,998.24	
ACCOUNTS RECEIVABLE				
Membership Dues	$17,657.84			
LESS: Reserve for Doubtful	14,537.57	3,120.27		
Advertisements	39,083.30			
LESS: Reserve for Doubtful	6,000.00	33,083.30		
Other	3,714.62			
LESS: Reserve for Doubtful	1,000.00	2,714.62	38,918.19	
INVENTORIES				
Transactions 1924-1929		1,870.87		
Transactions 1930 in Process		706.32		
Emblems and Certificate Frames		113.20		
Postage		644.20	3,334.59	
PERMANENT				
Library		300.00		
Furniture and Fixtures	5,165.61			
LESS: Reserve for Depreciation	2,216.47	2,949.14	3,249.14	
DEFERRED CHARGES				
Meetings 1932			149.58	$61,915.76
SPECIFIC FUNDS				
ENDOWMENT FUND				
Securities at Cost (Market Value $10,237.50)	19,753.68			
ADD: Accrued Interest	250.83	20,004.51		
Cash on Hand for Deposit		1,025.00	21,029.51	
F. PAUL ANDERSON AWARD FUND				
Cash on Deposit		337.90		
Cash on Hand for Deposit		685.53	1,023.43	
RESEARCH LABORATORIES FUND				
Cash on Deposit—Research	8.25			
Cash on Deposit—Research Endowment fund	335.53			
Cash on Hand for Deposit Endowment fund	1,724.51	2,068.29		
Securities at Cost (Market Value $2,610.00)	3,007.50			
ADD: Accrued Interest	45 00	3,052.50	5,120.79	27,173.73
				$89,089.49

LIABILITIES AND CAPITAL

SOCIETY			
ACCOUNTS PAYABLE		$10,984.33	
DUE RESEARCH LABORATORIES			
Dues		6,491.19	
ACCRUED ACCOUNTS			
Bonus to Staff		3,008.62	
RESERVE FOR TRANSACTIONS			
1930	$ 3,000.00		
1931	4,000.00	7,000.00	
DEFERRED INCOME			
Prepaid Dues		206.75	
TOTAL LIABILITIES		27,690.89	
GENERAL FUND			
Society		34,224.87	$61,915.76
SPECIFIC FUNDS			
Endowment		21,029.51	
F. Paul Anderson Award		1,023.43	
Research Laboratories	4,510.75		
Research Endowment Fund	610.04	5,120.79	27,173.73
			$89,089.49

NOTE "A" The General Fund of the Society is subject to future adjustment pending action to be taken by council on the assignment of the Guide Profit for the Calendar Year 1931.

NOTE "B" This Balance Sheet is subject to the comments contained in the letter attached to and forming a part of this report.

INVENTORIES

There is scheduled below the inventory of TRANSACTIONS taken on December 31, 1931.

Year	*Volume*	*Number*	*Price*	*Amount*
1924	30	273	138 1/4	$ 377.42
1925	31	168	96 1/6	161.56
1926	32	106	126 4/5	134.41
1927	33	154	132 3/5	204.21
1928	34	224	143	320.32
1929	35	313	215	672.95
Total				$1,870.87

TRANSACTIONS covering the year 1930, volume 36, and the year 1931, Volume 37, were not published up to the close of the current year, therefore reserves of $3,000.00 and $4,000.00 respectively have been provided to cover the future cost thereof.

All other inventories were verified either by actual count or analysis of the records.

ACCOUNTS PAYABLE

A list was compiled of all invoices remaining unpaid on December 31, 1931 dating prior to January 1, 1932, for the purpose of determining all Accounts Payable, and a liability therefor was set up in the sum of $10,984.33. This sum includes charges from Horn-Shafer Co. of $9,851.29 for costs covering the printing of the Guide and Year Book.

DUE RESEARCH LABORATORIES

Of the dues charged to Seniors and Associates, 40% has been reserved for the Research Laboratory in accordance with Section 5, Article 3, of the By-Laws. The sum payable to the Research Laboratory as and when the Dues Receivable will have been realized in cash is $6,491.19.

ACCRUED ACCOUNTS

A bonus of $3,008.62 to the staff of the Society has been included as a liability on the subjoined Balance Sheet. The computation of this bonus has been made in accordance with resolution adopted by Council.

GENERAL FUND

An analysis of the General Fund of the Society showing the changes made therein during the year under audit is as follows:

General Fund, January 1, 1931—per former report		$32,188.72
Addition		
Profit from Guide for the Calendar Year 1931 from Guide Statement of Income and Expenses		3,154.75
		$35,343.47
Deductions		
Loss from Society activities for the Calendar Year 1931 from Society Statement of Income and Expenses	*$1,093.60*	
To charge General Fund with refund of 1930 dues to life member	25.00	1,118.60
General Fund December 31, 1931—per balance sheet		$34,224.87

MEMBERSHIP

A comparison of the membership in force as of the close of business December 31, 1930 and 1931 respectively, follows:

Classification	*1931*	*1930*	Increases *Decreases*
Members	1,539	1,485	54
Associates	490	480	10
Juniors	203	246	*43*
Students	22	16	6
Honorary	2	2	0
Totals	2,256	2,229	27

Respectfully submitted,

FRANK G. TUSA,
Certified Public Accountant.

BUDGET COMPARISON—SOCIETY ACTIVITIES

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
NEW YORK CITY
For the Year Ended December 31, 1931

	Actual 1931	Budget Provision	Increases *Decreases*
INCOME			
Current Dues—Less Reserve	$25,798.73	$28,000.00	*$2,201.27*
Initiation Fees	2,213.00	4,000.00	*1,787.00*
Sales—Emblems and Certificate Frames	219.50	350.00	*130.50*
Sales—Codes	5.00	100.00	*95.00*
Sales—Journal and Non-Member Subscriptions	73.10	100.00	*26.90*
Sales—Reprints and Books	868.36	1,000.00	*131.64*
Sales—Transactions	642.25	800.00	*157.75*
Editorial Contract—Less Subscriptions	12,518.63	13,500.00	*981.37*
Interest Earned—General Funds	620.00	620.00	—0—
Interest Earned—Current Funds	186.43	280.00	*93.57*
TOTALS	$43,145.00	$48,750.00	*$ 5,605.00*
EXPENSES			
Salaries (Exclusive of Secretary)	$12,503.15	$12,000.00	$ 503.15
Postage	2,038.96	1,800.00	238.96
General Printing	895.03	1,000.00	*104.97*
Year Book	949.98	900.00	49.98
Transactions—1931	5,373.25	3,500.00	1,873.25
Reprints and Books	603.68	800.00	*196.32*
Emblems and Certificate Frames	205.82	300.00	*94.18*
Meetings—Annual and Semi-Annual	2,807.38	3,000.00	*192.62*
Meetings—Council and Special Committees	607.79	1,000.00	*392.21*
Traveling—President	1,000.00	1,000.00	—0—
Dues	60.00	60.00	—0—
Codes	660.68	1,000.00	*339.32*
Publicity	902.72	1,000.00	*97.28*
President's Emergency Fund	445.80	500.00	*54.20*
75% of Apportionable Expenses	13,749.70	14,775.00	*1,025.30*
	42,803.94	42,635.00	168.94
COMMITTEE ON RESEARCH EXPENSES	955.59	—0—	955.59
UNBUDGETED EXPENSES			
Transactions Index	278.57	—0—	278.57
Membership Campaign Expenses	111.50	—0—	111.50
Engraving Certificates	89.00	—0—	89.00
	$44,238.60	$42,635.00	$ 1,603.60
	$ 1,093.60	$ 6,115.00	*$ 7,208.60*

BUDGET COMPARISON—GUIDE

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
NEW YORK CITY
For the Year Ended December 31, 1931

	Actual	Budget Provision	Increases *Decreases*
INCOME			
Advertising	$32,760.76	$38,000.00	*$ 5,239.24*
Sales	11,778.28	14,500.00	*2,721.72*
TOTALS	$44,539.04	$52,500.00	*$ 7,960.96*
EXPENSES			
Printing and Binding 1932 Issue	$11,335.74	$13,500.00	*2,164.26*
Mailing 1932 Issue	300.00	1,500.00	*1,200.00*
Paper Purchases	2,482.07	2,800.00	*317.93*
Engraving and Art Work	469.03	600.00	*130.97*
Sales Promotion	2,702.73	2,000.00	702.73
Postage and Mailing 1931 Issue	2,033.83	1,600.00	433.83
Salaries (Except Secretary)	7,469.03	7,300.00	169.03
25% Apportionable Expenses	4,583.24	4,925.00	*341.76*
TOTALS	$31,375.67	$34,225.00	*2,849.33*
GUIDE PROFIT	13,163.37	18,275.00	*5,111.63*

Report of Publication Committee

The next report was that of the Publication Committee which was submitted by W. A. Rowe, chairman, who outlined briefly the duties of the Publication Committee and stated that about 25 papers had been scheduled for Society meetings, approximately equally divided between the Summer Meeting 1931 and the Annual Meet-

ing 1932. Nine papers had been rejected or had been withdrawn by the authors. The reasons for rejecting these papers were varied, he said, but many of them could more properly be handled through the advertising pages of the trade press, whereas others were of a more or less controversial nature and could serve no particularly useful purpose. Mr. Rowe enumerated some of the publications which had been sent out during the year and expressed his appreciation for the high type of papers that had been submitted during his chairmanship.

Report of the Committee on Research

The Report of the Committee on Research was submitted by C. V. Haynes, chairman, who stated that his report would be presented in conjunction with Director Houghten's report. (Report published in *Heating, Piping and Air Conditioning,* February 1932, page 149). The printed report, Mr. Haynes stated, included the reports of the various Technical Advisory Committees, as well as that of Mr. Houghten and himself.

Mr. Haynes said that there had been five research meetings during the year. He pointed out that there had been some difficulty in getting a quorum together. The Regulations Governing the Committee on Research state that seven members shall constitute a quorum. This was changed at the meeting at Swampscott, Mass., on June 22, 1931, to five, thereby making it possible for the committee to function more satisfactorily. This change in the quorum requirements was approved by the Society at the Semi-Annual Meeting 1931. Mr. Haynes called attention to the fact that a committee had been appointed to revise the Regulations Governing the Committee on Research so that the Regulations will synchronize with the By-Laws of the Society.

Chairman Haynes said that a letter had been sent out during 1931 to solicit research suggestions. These suggestions were so numerous that it required a considerable amount of time to analyze and classify them as to whether they were within the scope of Society research activities or not. He advised that these classified research suggestions would be published in *Heating, Piping and Air Conditioning* at an early date, and then proceeded to discuss the various classifications that had been adopted. Mr. Haynes outlined the duties of the chairmen of the Technical Advisory Committees, the work of whom will be coordinated by Prof. A. C. Willard, who was appointed in 1931 to act as Technical Adviser to the Committee on Research. He then discussed the institutions with which the Society maintains cooperative agreements, and outlined briefly some of the work being carried on at these institutions. He mentioned particularly the garage ventilation study at Pittsburgh and at the University of Kansas, under the direction of the Technical Advisory Committee on Ventilation of Garages and Bus Terminals, of which E. K. Campbell is chairman.

The financial status of the Committee on Research was next discussed by Mr. Haynes and he outlined some of the difficulties encountered in soliciting funds during this present period. Chairman Haynes summarized briefly the various sources of income upon which the Committee on Research must depend for the existence of the Research Laboratory at Pittsburgh and the research program in general.

F. C. Houghten immediately followed Mr. Haynes with the report of the Director of the Research Laboratory at Pittsburgh. (Report published in *Heating, Piping and Air Conditioning,* February 1932, page 149).

Financial Report of Research Laboratory

January 9, 1932.

Research Laboratory of the American Society of Heating and Ventilating Engineers,
51 Madison Avenue,
New York, N. Y.

Gentlemen:

As requested I audited the books of account and records of the Research Laboratory of the American Society of Heating and Ventilating Engineers, Pittsburgh, Pa., for the year ended December 31, 1931, and submit herewith my report.

CASH RECEIPTS AND DISBURSEMENTS

Research Laboratory of the American Society of Heating and Ventilating Engineers—Pittsburgh, Pa.

For the Year Ended December 31, 1931

BALANCE JANUARY 1, 1931, PER FORMER REPORT			$10,791.18
RECEIPTS			
From the American Society of Heating and Ventilating Engineers	$22,519.85		
Other Contributions—Per Schedule	10,283.00	$32,802.85	
Interest on Bank Balances	71.21		
Interest on Securities—Research	135.00		
Interest on Securities—Research Endowment Fund	1,025.00	1,231.21	34,034.06
			44,825.24
DISBURSEMENTS			
Salaries—Per Schedule		18,517.63	
Traveling—F. C. Houghten	1,204.84		
Traveling—Staff	86.24		
Traveling—Executive Committee	397.13	1,688.21	
Laboratory Equipment and Supplies		1,131.36	
University Cooperation—Per Schedule		14,448.60	
Meetings		93.75	
OFFICE EXPENSES			
Telephone and Telegraph	68.33		
Postage	121.56		
Stationery and Printing	22.95		
Professional Services	100.00		
Expressage	9.51		
Miscellaneous	296.42		
Furniture and Fixtures	70.00	688.77	
EXPENDITURES—LABORATORY			36,568.32
OTHER EXPENSES			
Research Booklet			
Paper and Printing	391.08		
Cuts and Photos	478.86		
Preparation	200.00		
Multigraphing	16.89		
Mailing and Postage	120.51	1,207.34	37,775.66
BALANCE DECEMBER 31, 1931			$ 7,049.58

BUDGET COMPARISON

Research Laboratory of the American Society of Heating and Ventilating Engineers—Pittsburgh, Pa.

For the Year Ended December 31, 1931

	Annual Disbursements	Budget Provision	Increases *Decreases*
Salaries	$18,517.63	$19,257.00	*$ 739.37*
Office Supplies and Expense	688.77	800.00	*111.23*
Traveling	1,688.21	2,000.00	*311.79*
Laboratory Supplies and Equipment	1,131.36	2,000.00	*868.64*
Contracts with Cooperating Institutions	14,448.60	12,150.00	2,298.60
Meetings	93.75	200.00	*106.25*
Contingent		400.00	*400.00*
Promotional Booklet and Other Promotional work	1,207.34	2,000.00	*792.66*
Stenographic Help—New York Office		800.00	*800.00*
	$37,775.66	$39,607.00	*$ 1,831.34*

CONTRIBUTIONS

RESEARCH LABORATORY OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—PITTSBURGH, PA.

For the Year Ended December 31, 1931

MANUFACTURERS		
Aerofin Corp.	$ 100.00	
American Blower Corp.	750.00	
Barnes & Jones	200.00	
Buffalo Forge Co.	500.00	
Carrier Engineering Co.	900.00	
Crane Co.	100.00	
Hoffman Specialty Co.	250.00	
Ilg Electric Ventilating Co.	200.00	
Mueller Brass Co.	1,000.00	
Nash Engineering Co.	335.00	
Powers Regulator Co.	200.00	
United Engineers and Constructors, Inc.	100.00	
Warren Webster and Co.	250.00	
Wolverine Tube Co.	25.00	$ 4,910.00
ASSOCIATIONS		
American Oil Burner Association	2,000.00	
National Lumber Manufacturers Association	2,800.00	
Ventilating Contractors Employers Association	573.00	5,373.00
		$10,283.00

COOPERATIVE RESEARCH PAYMENTS

RESEARCH LABORATORY OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS—PITTSBURGH, PA.

For the Year Ended December 31, 1931

Armour Institute of Technology	$ 573.60
Association for Correlating Thermal Research	500.00
Harvard University	500.00
Texas A. & M. College	950.00
University of Minnesota	1,750.00
University of Minnesota—National Lumber Manufacturers Association	2,500.00
University of Illinois	3,750.00
University of Wisconsin	1,375.00
Washington University	250.00
Yale University	2,300.00
	$14,448.60

Respectfully submitted,
FRANK G. TUSA,
Certified Public Accountant.

The next report was that of the Guide Publication Committee which was briefly summarized by D. S. Boyden, chairman.

Report of the Guide 1932 Publication Committee

STATISTICAL DATA

Number of books printed	12,000
Number of advertisers	188
New advertisers	40
Number of pages—Text Section	552
Number of pages—Advertising Section	304
Number of pages—Membership Section	64
Income from Advertising, THE GUIDE 1932	$33,260.82
Cost of Producing THE GUIDE 1932	$29,422.87

The first edition of THE GUIDE was published in 1922. Since that time many developments and changes have taken place in the field of heating, ventilation and air conditioning. The respective Guide Publication Committees have endeavored to keep pace with these developments in the successive issues.

The 10th edition of THE GUIDE has been extensively revised and amplified. The Text Section has been enlarged and the number of chapters increased from 35 to 40, more than half of the subject material being new material.

Chapter 1 is entirely new and is intended to interpret the definitions and abbreviations used in the Text Section. The Guide Publication Committee was assisted by the A. S. H. V. E. Committee on Definitions in the preparation of this chapter. While Chapters 2, 3, 4 and 5 contain a large amount of data and information which were included in THE GUIDE 1931, many important changes have been made to keep pace with the developments in the available information on these subjects.

A large percentage of the subject matter in Chapter 6, Radiators, is new, while Chapter 7, Gravity Convectors, was introduced to meet the demand for more detailed information concerning concealed heating units of various types.

Chapter 8, Hot Water Heating Systems, is based on recent developments in the design and installation of this type of heating system, and on the results of the cooperative research between the Society and Texas Agricultural and Mechanical College.

Chapter 9, Steam Heating Systems and Pipe Sizes, contains some important revisions and additions. An entirely new treatment of the subject of Devices for Handling Condensate and Air is given in Chapter 10, only a small amount of this text having been previously published in THE GUIDE.

The following three chapters relate to pipes: Chapter 11, Pipe, Fittings, Valves and Pipe Welding, contains new and useful information on pipe welding. Chapter 12, Pipe Insulation, includes convenient tables for estimating the heat losses from bare and insulated pipes; Chapter 13, Domestic Water Requirements and Pipe Sizes, is a new chapter and contains practical data on estimating domestic hot and cold water requirements for buildings of various types, and pipe sizes therefor.

The several chapters immediately following deal with fuels and devices employed in the combustion thereof. The treatment of boilers has been extensively amplified, whereas the chapter on Draft and Chimneys is an entirely new one. Chapter 16, Fuels, has been revised and amplified, whereas the treatment of Mechanical Stokers in Chapter 17 is new.

Although many of the old cuts were used in Chapter 23, Automatic Temperature Control, the text matter of this chapter has been completely changed in accordance with recent developments. The subject of Ventilation of Public Buildings, covered in Chapter 24, has been rewritten, whereas the Principles of Air Conditioning in Chapter 27, Air Conditioning in Relation to Comfort and Health in Chapter 28, and Air Conditioning for Industrial Processes in Chapter 29, are almost entirely new material.

The Design of Central Fan Systems in Chapter 31, was condensed from the chapters in THE GUIDE 1931 dealing with fan furnace and fan steam heating, with new material added. Considerably more than half of Chapter 32 on Air Distribution Systems, is new. Some of the charts in this chapter, while similar to charts which have previously appeared in THE GUIDE, have been revised on the basis of recent data.

Chapter 36, Unit Ventilators, Chapter 37, Unit Air Conditioners and Coolers, Chapter 38, Smoke, Dust and Cinder Abatement, Chapter 39, Physical Data, and Chapter 40, General Information, are, with the exception of a small amount of material which has been previously published in THE GUIDE, entirely new.

In behalf of the members of the Society and the profession at large, the Guide Publication Committee extends its sincere appreciation for the loyal cooperation given by the following engineers whose efforts have made the Text Section of THE GUIDE 1932 the largest and most comprehensive of these annual reference volumes:

HAROLD L. ALT
O. W. ARMSPACH
J. L. BLACKSHAW
C. A. BOOTH
C. P. BRIDGES
R. M. CONNER
V. S. DAY
N. W. DOWNES
M. W. EHRLICH
J. E. EMSWILER
M. D. ENGLE
J. A. FLEMINGS
F. E. GIESECKE
F. W. HANBURGER
L. A. HARDING
ELLIOTT HARRINGTON
J. H. HOLTON
F. C. HOUGHTEN

JOHN HOWATT	PERCY NICHOLLS
A. F. KARLSON	R. W. NOLAND
A. P. KRATZ	E. C. RACK
G. L. LARSON	W. M. RICHTMANN
F. J. LINSENMEYER	S. I. ROTTMAYER
GEORGE W. MARTIN	C. J. SCANLAN
V. D. MILLIKEN	L. E. SEELEY
J. G. MINGLE	E. SZEKELY
A. W. MOULDER	J. H. WALKER
H. C. MURPHY	C. P. YAGLOU

In the Catalog Data Section will be found sizes, shapes, capacities, dimensions, space requirements and applications so important to the engineer and contractor in planning, specifying and installing materials and equipment. The two sections are so interlocked that they are practically indispensable to each other, and for the best results it is recommended that the corresponding references in each section be consulted in all cases. The Catalog Data Section is dedicated to the presentation of reliable facts and figures concerning the products shown, eliminating as far as possible unnecessary *sales talk* and comparisons.

It is the sincere hope of the Guide Publication Committee that this book will be increasingly valuable to the profession at large, and to the students in schools and colleges who have found it to be a reliable and valuable text book.

GUIDE PUBLICATION COMMITTEE
D. S. BOYDEN, *Chairman*
W. L. FLEISHER
H. S. HALEY
S. R. LEWIS
L. T. M. RALSTON
P. D. CLOSE, *Technical Secretary*

Report of Committee on Meetings Program

The activities of the Committee on Meetings Program were summarized by Prof. G. L. Larson, chairman, who stated that many valuable papers covering practically all phases of heating, ventilating and air conditioning were accepted by the Publication Committee, and considered by the Committee on Meetings Program for 1931-32 meetings of the Society. Of the 36 papers published in 1931, twelve were presented at the Semi-Annual Meeting 1931 at Swampscott, and fourteen are scheduled for presentation at the Annual Meeting 1932.

He suggested that the new Committee on Meetings Program endeavor to obtain papers on proportioning of heating surface in tall buildings, as there have been numerous requests for information on this subject. He also suggested papers on lag factors in heating plants showing the true relation between the boiler load and the actual load, rather than the relation between the boiler load and the connected load.

The report of the Society's representative on the Committee of Ten was submitted by J. H. Walker. A report was also submitted by T. M. Dugan relative to American Standards Association Committees dealing with valves, fittings and pipe threads.

The report of the Tellers of Election was submitted by F. A. Kitchen, chairman, as follows:

Report of Tellers of Election

President—F. B. ROWLEY..... 578
First Vice-President—W. T. JONES..... 582
Second Vice-President—C. V. HAYNES..... 574
Treasurer—F. D. MENSING..... 582
Members of the Council—Three Year Term:
F. E. GIESECKE..... 583
G. L. LARSON..... 583
J. F. McINTIRE..... 580
W. E. STARK..... 582
Members of the Committee on Research—Three Year Term:
D. E. FRENCH..... 569
F. E. GIESECKE..... 568
L. A. HARDING..... 570
A. P. KRATZ..... 569
G. L. LARSON..... 570
Total ballots cast..... 644
Disqualified..... 59

Scattered votes were recorded for various other members.

TELLERS OF ELECTION
F. A. KITCHEN, *Chairman*
C. E. LEWIS
R. G. OLSON

Cleveland, Ohio, January 26, 1932.

The first paper was that entitled Surface Coefficients as Affected by Direction of Wind, by F. B. Rowley and W. A. Eckley, and summarizes the results of cooperative research between the Society and the University of Minnesota. (Published in *Heating, Piping and Air Conditioning,* October 1931, page 870).

Perry West stated that the authors should be congratulated on this presentation from two standpoints, *first,* the question as to whether the factors would be the same at various angles, and the *second,* the presentation of a new and unique method of exploring air currents. L. A. Harding stated that it was very gratifying to him to learn that the results of these studies had verified the work produced at the University of Illinois about 16 years ago indicating that the values for the outside surface coefficients should be about 3 or 3½ times the values for still air conditions, which is the basis upon which the coefficients in the A.S.H.V.E. GUIDE 1932 are calculated.

In a written discussion of this paper, Percy Nicholls expressed the opinion that the authors had undertaken a difficult task in attempting to determine the effect of the angle of the wind on heat transfer. He could not see how the problem could be dissociated from the area of the surface. He stated that although the authors had reasoned that the true surface coefficient is not greatly affected by the general direction of the wind striking it, yet he believed it would be incorrect to conclude that the total heat loss by that wall would not usually be increased by direct impingement.

J. G. Shodron presented two slides relating to certain questions he desired to ask. His first question was that of the effect of dry air inleakage upon the outside surface coefficient, the internal conductance coefficient and the inside surface coefficient as well as the overall coefficient of transmission. His second question was that of the effect of humid air outleakage on the outside surface coefficient, the internal conductance of the inside surface coefficient, and the overall coefficient of transmission.

In his closure, Professor Rowley said that in his opinion there would be an additional heat loss due to infiltration, but that the transmission coefficient would be the same; in other words, that the infiltration and conductance factors are entirely separate. If infiltration takes place through the wall, the temperature head will be decreased, the heat transmission will be reduced and the

coefficient will be reduced, but if there is no change in the temperature drop between the air on the two sides, it was Professor Rowley's opinion that the heat loss by conductance would be the same and the coefficient would be the same, other factors being the same, but the infiltration would be increased. As to the matter of humidity, Professor Rowley pointed out that the warm humid air from the inside of the building would condense when it comes in contact with cooler surfaces, and the conductivity of the material would be changed due to the moisture in the material.

A paper entitled, Conductivity of Concrete by F. C. Houghten and Carl Gutberlet, resulting from research conducted at the A.S.H.V.E. Laboratory at Pittsburgh, was presented by Director Houghten. (Published in *Heating, Piping and Air Conditioning,* September, 1931, p. 778). Professor Rowley pointed out that it has been customary in the past to use a conductivity for concrete of 8.3 whereas these tests show that the value should be somewhere between 10.0 and 12.0. He stated that the conductivity seems to vary with the moisture in the concrete, but after the wall has thoroughly dried, evidently there is some other effect than that of moisture. He referred to some tests at the University of Minnesota which showed that the coefficient remained fairly constant for 22 months, but after a three-year period it dropped to 10.7, which may have been due, he said, to different air conditions in the laboratory. Professor Rowley expressed the opinion that the coefficient for concrete should be increased.

In a written discussion, E. C. Rack stated that he was in general accord with the conclusions of the authors, but questioned whether the value of 12 would apply as a general factor for all concrete, and whether this value without qualification may not be somewhat more than conservative for the use recommended. Prof. E. R. Queer presented a written discussion and related some of the experiments conducted at Pennsylvania State College on concrete. He pointed out that the value of 12 appeared to be a fair average for the conductivity of stone aggregate concrete.

Discussions were also submitted by A. B. Shenk and J. H. Bracken. Mr. Shenk stated that in his opinion there was considerable argument in favor of continuing the use of a value in the neighborhood of 8.3 for concrete. Mr. Bracken commended the authors for the work and for the conclusions reached and urged that the Society adopt a value of 12, or even higher.

L. A. Harding pointed out that the difference between the higher and the lower values in the conductivity of any material was due largely to the method of testing. He said that the low values of concrete reported for a number of years, had been invariably made on large size specimens by the old-time hot box method.

H. P. Reid drew attention to the fact that concrete can be designed to have almost any heat loss factor, depending to a large extent on the type of aggregate used. He said that the wide variation in values reported was undoubtedly due to factors other than density. Mr. Reid thought that the study could be extended to include the effect of aggregate and of the volumetric and weight proportions of the cement to the aggregate.

W. L. Fleisher seemed to think that the practical significance of this paper had not been sufficiently emphasized, namely, that a variation is likely to take place in the conductivity of concrete over a period of two years. President Carrier agreed that Mr. Fleisher's point was an important one, and cited a case where a building had been humidified without any humidifying equipment simply from the evaporation from the concrete or plaster.

A paper entitled Transmission of Radiant Energy Through Glass, by R. A. Miller and L. V. Black, was presented by Mr. Miller. (Published in *Heating, Piping and Air Conditioning,* February 1932, page 143).

After a most excellent presentation of this paper by Mr. Miller, President Carrier expressed his indebtedness to the authors for this contribution, and said that it is not generally realized that radiation does not pass through glass. He stated that it had been assumed by most people that sunlight and high temperature flames pass through glass, and that the transmission was proportional for the lower wave lengths. Glass, according to Mr. Carrier, does not act as a radiation shield the same as iron does. President Carrier, Mr. Miller and Mr. Black entered into a brief discussion concerning the coefficient of radiation of various substances.

F. C. Houghten related some of the experimental work at the A.S.H.V.E. Laboratory dealing with radiation from the sun, and stated that their results showed that double strength window glass absorbed from 10 to 16 per cent of the energy from the sun. He stated that if an incandescent tungsten light bulb is used as the source of radiation, a thin glass plate will absorb from 20 to 30 per cent of the radiation. If the source of light is a low-temperature electric heater, the glass will absorb from 60 to 70 per cent of the total radiated energy, according to Mr. Houghten, whereas if the source of radiation is a black iron plate heated to a temperature of 212 F, the same piece of glass will substantially cut out all of the radiation.

President Carrier inquired as to whether Dr. Knudsen had any remarks to make concerning this paper from the physical standpoint, to which Dr. Knudsen replied that he would like to discuss the previous paper. In this connection he called attention to a concrete chamber which had a period of reverberation of 12 sec shortly after it was constructed, which was reduced to 10 sec after the concrete had aged for a year, and to 8 sec after the concrete had aged for two years, thus indicating that the aging of concrete has a bearing not only on the heat insulation properties of the material, but also the sound-absorbing characteristics.

Mr. Miller stated that he neglected to mention that in the comparison between a single plate of glass ½-in. thick and two plates of ⅛-in. glass spaced ⅜-in. apart, the actual apparent transmission from the colder surface of the ½-in. plate is materially higher than the radiation from the colder surface of the two plates placed with an air space between.

L. A. Harding inquired as to whether the Stefan-Boltzmann Law applies in the case of these experiments, to which Mr. Miller replied in the affirmative. Mr. Miller and Mr. Harding then engaged in a brief discussion on the Stefan-Boltzmann Law and its accuracy

for high temperatures. Professor Rowley thought that the law was correct, but that the coefficients are different at higher mean temperatures. For the shorter wave length, Professor Rowley said, the coefficients apparently are reduced and become practically zero for very short wave lengths at high temperatures. A. P. Kratz pointed out that the Stefan-Boltzmann Law applies to a black body or a perfect radiator, and this is where many engineers make a mistake. E. R. Queer insisted that the variable factor in the Stefan-Boltzmann Law is the emission factor, but L. A. Harding stated that it had been proved that the law does not hold true at high temperatures.

Mr. Harding, in discussing the paper Conductivity of Concrete, again referred to the difference in the results obtained by various methods of conductivity tests, and suggested that the hot-box method gives the lower value. He urged that comparative tests be conducted. President Carrier agreed that this was an important point and expressed the opinion that there was really a practical difference in the method of testing. Mr. Harding said that the hot-box method more nearly approaches the actual heating and ventilating installation.

Second Session—Tuesday, January 26—2:00 P. M.

The first paper to be presented at the second session was that entitled, Importance of Radiation in Heat Transfer Through Air Spaces, by E. R. Queer. (Published in *Heating, Piping and Air Conditioning,* November 1931, page 960).

In a written discussion, W. J. King pointed out that engineers in general seemed to be inclined to underestimate the importance of radiation in low temperature heat transmission, and that the significance of this factor needs to be emphasized. He said that some authors had compared the conductance of several 1-in. air spaces with that of cork or some other commercial insulating material, and that under these conditions the air spaces show up to a disadvantage.

E. C. Rack submitted a written discussion in which he stated that while it had been brought out that increasing the spacing of baffles increases the resistance to heat flow, it should be remembered that these tests were made on specimens prepared especially for laboratory use and were necessarily sealed so as effectively to prevent air leakage into and from the pockets. He also suggested that the author include in this report the ratio of the guard ring width to the length of one side of the main heater as it applied for the hot plate apparatus used in his various tests.

E. B. Svenson advised that although the effectiveness of polished metal screens in preventing heat radiation had been known for some time, it had been of little advantage in the insulating field until recently. In Mr. Svenson's opinion, it was hard to believe that there is no advantage from the insulating standpoint of restricting the height by means of partitions bounded by metallic surfaces.

Professor Rowley stated that in analyzing the problem so far as straight heat transmission is concerned, there is more than one element to consider, and he said that this is probably where we have erred in the past. Mr. King called attention to the importance in making a study of this nature of first investigating the literature on the subject to get the advantage of what had already been done in the past in that field. He mentioned the fact that in Germany a great deal of activity is being manifested on this subject at the present time.

In a written discussion, Percy Nicholls ventured the opinion that the paper had the same weakness as the majority of reports of investigators of heat transfer, namely, that it does not include check tests to confirm the order of accuracy of instruments, apparatus, methods and results.

In his closure, Professor Queer discussed the multiple spacers which were placed 0.37 in. apart. This spacing, he said, was modified because the theoretical determination did not hold true experimentally. He stated, however, that the spacing of 0.37 in. with the type of foil that was used, gave the lowest conductance value per inch. Professor Queer, in replying to a statement by one of those who had discussed the paper, said that while filling in air space frequently eliminates radiation, most insulating materials have higher conductances, due to heat transfer by pure conduction, than do brittle metallic foils. Professor Queer explained that aluminum foil was used on account of the permanence of the surface during the test. Any other brittle metallic foil would have served the purpose, he stated, provided the surface had remained fairly constant during the test period.

President Carrier introduced R. L. Spitzley, president of the *Heating and Piping Contractors National Association,* who extended the greetings of that organization. He thanked the Society for the co-operation it had extended to his organization, because most of the standards that the two organizations are using, he said, have been the outcome of co-operation of the committees.

A paper entitled, Heat Emission from Iron and Copper Pipe, by F. C. Houghten and Carl Gutberlet, resulting from research conducted at the A.S.H.V.E. Laboratory, Pittsburgh, was presented by Mr. Houghten. (Published in *Heating, Piping and Air Conditioning,* January 1932, page 47).

F. W. Hvoslef inquired as to why Mr. Houghten specified copper as received, and wanted to know if it was new shiny copper pipe or copper that had been lying in the atmosphere for a while. Mr. Houghten replied that it was copper purchased on the market and which, of course, had not been buffed and that after it had been buffed, the emissivity was reduced considerably. Mr. Hvoslef related that he had been approached by a salesman selling copper tubing and fittings who endeavored to persuade him to use copper for steam mains because he claimed it would not be necessary to cover them, and based his statement on this paper. W. J. King pointed out that if a considerable thickness of poor insulation is added so as to increase the amount of surface exposed, the effect of this insulation blanket is more than offset by the increase in surface area. A ½-in. pipe, he averred, will have a relatively small amount of dissipating surface. He contended, therefore, that it is better to use a bare pipe than a *poor* insulation.

In reply to a question concerning the effect of oxida-

tion of the copper pipe on the heat emission, Mr. Houghten stated that the effect would be to materially increase the heat given off, which is indicated to some extent by Table 4 of the paper.

C. A. Hill explained certain effects due to annealing which would be likely to change the heat emission. Chairman Rowley stated that it was evident that changing the surface of the material changes the coefficient, and hence, if the copper ages or the surface is changed in some manner, the heat emission will be changed.

The next scheduled paper was entitled, Supplementary Friction Heads in One-Inch Cast Iron Tees, by F. E. Giesecke and W. H. Badgett, which was the result of research conducted at Agricultural and Mechanical College of Texas in co-operation with the A.S.H.V.E. Research Laboratory. (Published in *Heating, Piping and Air Conditioning,* January 1932, page 53). On account of the absence of the authors, the paper was presented by title.

Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, by R. E. Hall and A. R. Mumford, was the next paper on the program, and was presented by Mr. Mumford who illustrated his talk by slides. (Published in *Heating, Piping and Air Conditioning,* November and December 1931).

W. W. Timmis discussed the effect of corrosion upon steam leakage through valves of the flat disc type and the cone type. He outlined certain commercial difficulties with manufactured products, due to corrosion in the system. The difficulty was invariably attributed by outsiders to improper functioning of the apparatus involved but had been proved to be due to corrosion. He said that they had come to the conclusion about two years ago that free oxygen was largely responsible for the corrosion in heating systems, and cited certain examples to prove the case.

Written discussions of this paper were submitted by Messrs. F. N. Speller, E. L. Chappell, H. D. Newell, Lewis Jones, S. E. Tray, E. B. Ricketts, R. M. Gates, N. Artsay, W. A. Shoudy and J. W. Degen.

The discussion was closed by Dr. R. E. Hall who stated that the investigation was undertaken for the New York Steam Corporation. Dr. Hall emphasized the fact that corrosion in the return lines occurs at specific points and not in general throughout the system, as for example, in the traps or in the nipples. This corrosion, he said, is mainly from iron oxide and collects at this point whether the nipple is of iron or of glass. Referring to carbon dioxide in regard to corrosion occurring in alkaline waters, Dr. Hall said that if there is enough oxygen in the water so that as it heats the oxygen is *squeezed out* of the water by its decrease in solubility, the formation of bubbles takes place. Although the water surrounding the bubbles may have the alkalinity of a caustic solution, there is no protection underneath the surface of the bubble, and pitting occurs. The speaker stated that a liquid containing 30 or 40 parts per million of carbon dioxide will be corrosive, but its *pH* value, that is its acidity, will be considerable. But if 30 or 40 parts per million are in the steam in contact with the condensate, he continued, the condensate cannot contain the slightest fraction of that 30 or 40 parts per million.

Third Session—Wednesday, January 27—10:00 A. M.

The third session was a joint meeting with the *American Society of Refrigerating Engineers,* and was held at the Little Theatre of the Cleveland Auditorium, with President Carrier in the chair.

President Carrier introduced A. H. Baer, president of the *American Society of Refrigerating Engineers,* and then announced the first paper entitled, Changes in Ionic Content of Air in Occupied Rooms Ventilated by Natural and by Mechanical Methods, by C. P. Yaglou, L. C. Benjamin and S. P. Choate. (Published in *Heating, Piping and Air Conditioning,* October 1931, page 865).

Written discussions by Dr. Ellsworth Huntington and Dr. W. J. McConnell were read by Secretary Hutchinson. Dr. Huntington stated that although Professor Yaglou's work does not prove that the ionic content of the air is the factor for which we have been searching, it does indicate that we are at least on the way toward a definite solution of the problem, and he expressed the hope that a series of experiments would be made in which the ionic content of the air is changed and the effect upon people's feeling observed. Dr. McConnell stated that so far there had been very little evidence to support the practice of artificially ionizing air, and it was gratifying to him to learn that this well planned and comprehensive investigation to determine the real value of ionization in relation to ventilation and health, was under way.

Mr. Houghten said that the problem of ionization bears a relationship to the art of ventilation similar to the relation of vitamins to food. He ventured to say that it is probable that this ionization of the atmosphere will prove to be the vital characteristic of the atmosphere for which we have been searching for some time. Dean F. Paul Anderson stated that the opinion has been expressed for many years that the characteristics of air are changed when the air is brought through ducts, but that there was no evidence to prove this fact. Rather, he said, there is a change when the air is brought into a room, a change in the electrical properties of the air due to the physical and physiological processes of the body. He cited as an example the exhilarating effect obtained when a person, after being confined indoors for some time, breathes the outdoor air which contains qualities which the ventilating engineer has not been able to supply thus far.

Mr. Torrence advanced the theory that the outside air has a vital effect on the metabolism of the human system. He also thought that if the metabolism is excessive it does more harm than good because it may, in his opinion, break down the tissues faster than the digestive processes can replace them. A. R. Stevenson said that he understood some experiments had been made in Germany along these lines, and inquired as to whether Professor Yaglou had conducted any investigations of this nature. Professor Yaglou replied that experiments had been carried on for about ten years by Professor Dessaur of the University of Frankfort, but that his work was confined to large ions. Professor Yaglou stated that he had done some work on the physiological and bacteriological effect of small and large ions and

he found that the small ions were much more active than the large ones.

John Aeberly pointed to many changes in our every day life, particularly in its relation to health, that would justify the continuation of this study. He cited two examples to show why scientific men are giving considerable thought to this subject. One was the fact that the hydrogen-ion concentration in the blood is fatal when it is too high and when it is too low. Another was that the medical profession has been unable to explain the reason for the high incidence of respiratory diseases in, for example, the printing industry which, in some way, may be tied up with the study of ionization.

E. Q. Cole inquired as to whether ionization can be accomplished by the air supplied or if it would have to be done by some separate means. Professor Yaglou replied that it could be controlled by the amount of air, but that the air supply required is so high that it is impractical. It would be much less costly to devise a special apparatus for controlling the ionic content in occupied rooms at any desirable concentration rather than introduce large quantities of air. In closing the discussion, President Carrier expressed the belief that the paper marks a milestone in the pathway of progress in the art of ventilation. Other written discussions of this paper were submitted by M. J. Rosenau, W. Ray Montgomery, F. E. Hartman, and J. I. Lyle and will appear in the TRANSACTIONS of the Society.

A paper entitled, Acoustical Problems in Heating and Ventilating of Buildings, by V. O. Knudsen, was presented by the author. (Published in *Heating, Piping and Air Conditioning,* December 1931, page 1035).

In opening the discussion of this paper, President Carrier remarked that his organization had experienced difficulty in collecting their money for a certain job because of noise, and called in Dr. Knudsen to help solve the problem. President Carrier cited some of the factors which contribute to the noise encountered in heating and ventilating systems, and said that probably one of the most serious difficulties is the noise from fans.

J. S. Parkinson said that to a great many people noise is a rather intangible thing and for that reason it is somewhat more difficult to understand than other forms of engineering problems. On the other hand, limits may readily be set up as the basis upon which the acoustical properties of a theatre may be predicted. He also said it was possible to predict quite accurately how much noise a given piece of equipment will introduce into a certain space and how much of that sound will be transmitted. Mr. Parkinson described some of the recent apparatus that has been perfected for aiding in the solution of this problem.

Written discussions were submitted by C. A. Andree, O. B. Hanson, V. L. Chrisler, S. K. Wolf, C. F. Eyring, F. R. Watson and R. H. Galt. These will appear in the 1932 TRANSACTIONS of the Society.

L. L. Smith inquired as to whether the correct design of ducts as to perimeter and shape from the standpoint of noise reduction, had been established. He drew attention to the difficulties encountered by the designer in laying out a duct system, due to space limitations and restrictions. Mr. Smith stated that even though the engineer may have complete data for reducing noise to the proper extent, he has these factors to consider.

In reply Dr. Knudsen said that if the noise level is specified, it can be obtained by means of the proper design of filters, several types of which are on the market. He further stated that the most simple method is that in which the loss of sound energy per foot is made as great as one or one and a half decibels per foot by using small cellular conduits lined with highly absorptive material. This necessitates increasing the cross-sectional area of the duct for the length required to produce the necessary sound absorption.

A. R. Stevenson inquired as to the point at which the noise level should be measured, stating that it would make a considerable difference as to where the readings were taken. Dr. Knudsen replied that if the total flux of sound energy from any source is known, and also the boundary materials of the room, the average intensity of sound energy in that room can be calculated, and the intensity of sound at any point is inversely proportional to the square of the distance of that point from the source of sound. Dr. Knudsen stated that the paper describes three standard methods for making these sound measurements.

The next paper, Heat Transmission as Influenced by Heat Capacity and Solar Radiation, by F. C. Houghten, J. L. Blackshaw, Paul McDermott and E. M. Pugh, was presented by Mr. Houghten, Director of the A.S.H.V.E. Research Laboratory, Pittsburgh. (Paper to be published in *Heating, Piping and Air Conditioning,* April 1932).

A. P. Kratz presented a synopsis of a written discussion by J. A. Goff, in which Professor Goff stated, among other things, that he did not feel that the results of this investigation had been presented in the simplest and most understandable form, although the experimental and analytical information is extremely valuable. L. A. Harding stated that this was the third in the series of papers on a study of solar radiation as it affects the design of heating and ventilating equipment. Mr. Harding presented a written discussion in which he submitted a simplified formula for solving the problem.

A. R. Stevenson said he was interested in this paper because the flow of heat through insulation is analogous to the flow of electricity along a cable and the mathematics could be directly applied. He declared that he had tested some refrigerating boxes some time ago and that it was discovered that the temperature inside the box follows the same general curve, but there is a heat rise after about four hours due to the heat capacity of the walls of the box.

President Carrier said he would entertain discussions on this paper so far as affecting the determination of winter load as calculated for extreme temperatures. E. K. Campbell stated that this paper was of particular value for buildings which are intermittently heated. For example, he said, if a church is cooled thoroughly at night by blowing a large volume of air through it, and the building kept closed after sunrise, the heat will be absorbed from the inner materials of the building during the night and these materials will in turn absorb heat from the audience during the service, so that there will be a lag in the temperature which will last well beyond noon.

President Carrier again referred to the maximum heat demand in the winter, and stated that while the present

methods of calculating heat losses are satisfactory for thin materials of small heat capacity, they are not accurate for the thicker and heavier walls with large heat capacity because of the lag effect. Hence, he said, a lesser heat flow must be considered where walls of high heat capacity are involved.

In closing the discussion of this paper, Mr. Houghten stated that it was not the intention of the authors to propose a final solution of this problem, and that short cuts would no doubt be developed such as the one presented by Mr. Harding. Replying to a question raised by Mr. Harding, Mr. Houghten said that the top surface temperature should not be a direct function of the sun intensity, because the outside air temperature is a factor in determining that surface temperature as well as the wind velocity.

The last paper on the program of the third session was Field Studies of Office Building Cooling, by J. H. Walker, S. S. Sanford and E. P. Wells. The paper was presented by Mr. Sanford. (Published in *Heating, Piping and Air Conditioning,* February 1932, page 125).

In a written discussion by L. L. Smith and H. L. Walton, they pointed out that the investigation indicated a considerable difference between the design values of the installation and the observed values in the test so far as sun effect was concerned. W. L. Fleisher inquired as to whether the heat transfer through the glass was determined with shaded glass or without, which he said would make a very considerable difference. Mr. Sanford replied that tests were made with the Venetian shade blinds half way down, that is, down to the meeting rails, and with the blades of the blinds in a horizontal position. Mr. Sanford said that tests were also run with shades all the way up and with the shades completely down and the blades closed so that practically no sunshine could enter. Strangely enough, he pointed out, the cooling loads in the two cases were almost identical and it was very difficult to find the difference between the shades up and the shades down. He said the answer probably was that the shades absorbed the heat and gave it off to the room, and whereas the occupants of the room were shielded from the vision effect of the sunlight, still the heat effect was there just the same.

Answering Mr. Smith's discussion, Mr. Sanford said there were several reasons why the cooling load as measured by the air did not agree with the calculated cooling load in the test rooms. One was that the windows in the test rooms were not as clean as they might have been, and another was that the sunlight in striking the floors and walls of the room doubtless was absorbed to a considerable extent and the heat was lost to the room. Mr. Sanford was inclined to disagree with the suggestion that had been made that the recommended values for solar radiation be reduced. A. R. Stevenson inquired as to the color of the Venetian shades used, to which Mr. Sanford replied that they were buff, the standard type of blind.

Mr. Sanford, in answering another question by President Carrier, stated that the pyrheliometer readings were taken on an area normal to the sun's rays, that is, the instrument was pointed directly at the sun, which gave absorption figures of 140 and 160 Btu for vertical glass. These figures, President Carrier said, did not agree with Mr. Houghten's figures, to which Mr. Sanford replied that the value of 196 Btu given on the last page of the paper, he understood, referred to a vertical glass.

President Carrier voiced the opinion that calculations used for glass areas and the allowance for shading had been too low, although other factors which had been considered, he continued, have compensated for this error to some extent. Mr. Carrier contended that it makes considerable difference whether the outside temperature averages 75 F or 85 F if the inside temperature being maintained is between 75 F and 80 F.

W. L. Fleisher inquired as to the effect of double glass on solar radiation, and asked if it would be possible to set the two glasses at angles so that part of the solar radiation would be reflected. Mr. Sanford replied that one part of the test consisted of taking readings through double glass, and the reduction in solar radiation intensity through one pane of glass, as measured by the pyrheliometer, was about 14 per cent, and for two panes of glass it was about 35 per cent. He added that the double glass is not as effective in keeping out solar radiation as it is in preventing the flow of heat due to ordinary transmission.

Fourth Session—Thursday, January 28—10:00 A. M.

This session was a joint meeting with the *American Society of Refrigerating Engineers* and was sponsored by that organization, President A. H. Baer of the *A.S.R.E.,* presiding.

Mr. Baer introduced the officers of the A.S.H.V.E. who were present, namely, President Carrier, Vice-President Rowley, and Secretary Hutchinson, and then announced the first paper entitled, Application of Refrigeration to Heating and Cooling of Homes, by A. R. Stevenson, Jr., F. H. Faust and E. W. Roessler, which was presented by Mr. Stevenson. In this paper the authors discussed the heat pump principle, gave an analysis of conditions in electric current costs and explained some of the difficulties involved.

The next paper on the program was entitled, Bacteria as Affected by Temperature, and was presented by the author, Dr. S. C. Prescott of the Massachusetts Institute of Technology.

The last paper was entitled, Air Conditioning as Applied to Cold Storage and a New Psychrometric Chart, by C. A. Bulkeley.

These papers appear in *Refrigerating Engineering,* the official organ of the *American Society of Refrigerating Engineers.*

Fifth Session—Thursday, January 28—2:00 P. M.

President Carrier introduced H. B. Gombers, a life member of the Society, and secretary emeritus of the *Heating and Piping Contractors National Association.* Mr. Gombers related some of his early experiences as a member of the Society, and read an interesting excerpt from the January 6, 1900 issue of *The Metal Worker.*

President Carrier announced that this session would be devoted to codes. The first report was that of the

Committee on Code for Testing and Rating Unit Ventilators and was submitted by John Howatt, chairman. This report had previously been sent to members of the Society.

After a motion by G. E. Otis to the effect that the code be adopted subject to mail vote with the proviso that it be put into effect on January 1, 1934, which motion was seconded by J. J. Aeberly, the code was placed before the meeting for discussion. W. A. Rowe stated that he would take it that it was the sense of the motion that the code be not effective until the date specified only so far as it concerns ratings already in existence and equipment already in existence. Mr. Aeberly thought that in order to be equitable all units should be rated on the old basis until the code becomes effective and then change them all to code basis. Mr. Otis stated that it would involve quite an expense to the manufacturers of unit ventilator equipment to test their machines on one basis and then to have to do the work all over again when a new code is adopted.

Prof. A. I. Brown offered a number of suggestions concerning the definitions of terms used, the use of barometric pressure, etc. Professor Brown questioned whether it was correct to specify a calibrated nozzle, and thought that the code should call for a standardized nozzle. He said that one would have to be extremely optimistic to obtain a coefficient of 99 per cent for a nozzle which, according to specifications, did not call for machine finish. Professor Brown also commented on the venting of air from the units, saying that it was his experience that a ⅛-in. petcock located at the position specified in the drawing did not give satisfactory results.

C. W. Brabbée said that it was not clear as to whether the tolerance of 2½ per cent in Paragraph 13 meant + or — 2½ per cent, or 2½ per cent. He thought it should read + or —2½ per cent. Dr. Brabbée considered that a petcock was not a satisfactory way of venting and thought it was possible to obtain satisfactory results with improved Pitot tubes.

Perry West offered a number of suggestions which he thought would improve the code. He suggested that the changes and corrections he had offered be included in the code before it is issued, and requested that the original motion be amended to this effect, which amendment was accepted by the mover and seconder.

J. D. Cassell inquired as to whether the amendment by Mr. West included the suggestions of Dr. Brabbée and Professor Brown. Mr. Aeberly suggested that the changes be submitted to the committee to revise the report as it deemed advisable in order to clarify the code.

The amendment by Mr. West was seconded and carried.

Mr. Rowe thought that the formulae did not lend themselves to the conditions of the test. He said that the intent of the Unit Heater Code was to permit the use of any desired orifices, but that if an orifice was used for which the coefficient were not known, it would be necessary to calibrate it. Mr. Rowe said that it had been pointed out at previous meetings when the Unit Heater Code was under consideration that the temperature determination was quite difficult without a thorough mixing of the air stream, and that if the air stream is passed through the nozzle at a high velocity, it affords a convenient place for making a single determination of the air volume and to that extent it is more reliable and accurate than a Pitot tube traverse at a low velocity and at the varying velocity gradients in the pipe.

E. H. Beling discussed certain forms to be used in connection with the Unit Heater Code, and stated that the committee of the *Industrial Unit Heater Association* of which he was chairman, would be glad to turn these forms over to the Committee on Code for Testing and Rating Unit Ventilators, as he said they would conform to Professor Brown's suggestions.

Referring again to the use of the Pitot tube, Dr. Brabée said that it was his idea that the code should not exclude adopted methods of measurement, and that the Pitot tube method was internationally used. In answer to an inquiry concerning the measurement of high velocity with the temperature measurement, Dr. Brabbée replied that it was not necessary with a Pitot tube.

Mr. Rowe said that in connection with the code committees of this nature with which he had been identified, it had been the practice to adopt one method. He claimed that the reason the orifice is used in the code under discussion is that a velocity of 3000 fpm is required to get an accurate temperature measurement, and since it was necessary to have this velocity, the orifice is a very convenient point to make one reading for volume. He further stated that if a traverse with a Pitot tube were used it would still be necessary to have a 30 hp motor to obtain the temperature measurements. Dr. Brabbée disagreed with the latter statement and said that he had made many tests on tubes of 4-in. in diameter.

Mr. Rowe explained that he was not contending that an accurate temperature velocity measurement cannot be obtained at other temperatures but the committee adopted a velocity of 3000 fpm as the minimum at which they could be certain of getting uniform temperature readings.

Dr. Brabbée questioned whether it would be necessary to have such a high velocity when working with the Pitot tubes, and strongly advised that another method be permitted in the code, one which he said was universally recognized. Mr. Otis pointed out that the matter had been discussed at length by the committee and that he originally was in favor of the Pitot tube method. The committee, he said, was unanimous in its belief that the method recommended was the most satisfactory when all factors are taken into consideration.

Thornton Lewis asked Dr. Brabbée how, if a velocity of 3000 fpm was not created, a temperature reading could be obtained of which one could be certain. Dr. Brabbée said that the method he used involved a small wheel with constant blades and by the use of such a wheel it was possible to obtain perfect air distribution and thereby a satisfactory temperature reading.

Vice-President Rowley assumed the chair, and President Carrier spoke in support of the position of the committee in selecting one method. While he was of the opinion that the Pitot tube method might be just as good, it would be necessary in his opinion to specify in detail its use and restrictions, giving provisions for taking temperatures, etc. Mr. Carrier said he would prefer to see the standards of the *A. S. M. E.* adopted for measuring air volume, in preference to the Pitot tube method. He said that the consensus of opinion of the members of

the *A. S. M. E.* Committee was that the Pitot tube should be resorted to only where it is impossible to get a more reliable method of measuring.

The judgment of the committee in the selection of a nozzle was commended by Mr. Carrier and he thought that the coefficient of 98.5 was about right for a standard nozzle. Professor Brown again inquired as to whether the code intends that this particular nozzle shall be used or any calibrated nozzle. Professor Brown also referred to the wording of the Unit Heater Code which expressed the use of a thin plate orifice, as he thought that this might likewise apply to the code under discussion.

President Carrier inquired as to whether he thought the committee would be in a stronger position if the proportions of the nozzle were specified in accordance with some recognized standard, in order to eliminate the question of calibration. Mr. Rowe stated that he would not object to an orifice in a thin plate if the conditions were right. President Carrier stated that if the code is to specify a nozzle, the nozzle should be accurately stated.

President Carrier resumed the chair and called for the motion as it had been amended, and the motion was carried. He then instructed the committee to revise the code in accordance with the suggestions received and that it be submitted to the members of the Society for vote by letter ballot.

The next report was that of the Committee on Ventilation Standards, by W. H. Driscoll, chairman. Before proceeding with the details of the report, Mr. Driscoll paid tribute to the personnel of the committee for their splendid, intelligent cooperation, and for the vast amount of time, effort and personal expense they had given to the matter. Mr. Driscoll also outlined the various steps leading up to the present report.

The Report of the Committee on Ventilation Standards, which had been prepared in mimeograph form and distributed to the audience, was read by Mr. Driscoll.

President Carrier stated that it was his understanding that the report would contain an appendix which would include definitions and recommendations as to the methods for bringing about the desired results, to which Mr. Driscoll replied that the only items which had been definitely decided upon for inclusion in the appendix were definitions of terms and tables of effective temperatures. He said there was also a possibility that the appendix might include a reference to natural ventilation and possibly to air volume.

In order to place the report before the meeting for discussion, J. J. Aeberly moved that the report be accepted and sent to the membership for adoption by letter ballot. This motion was seconded by Thornton Lewis.

H. M. Nobis referred to Section I on Air Temperature and Humidity, and inquired as to the matter of automatic control, and also the question of ceiling temperature. In connection with the latter question he referred to certain difficulties which might be encountered with a room having a ceiling height of say 14 ft and a mezzanine floor. As to the section on Air Quality, Mr. Nobis was of the opinion that there should be a fixed standard or a maximum number of dust particles per cubic foot. Referring to Section III dealing with Air Motion, which specifies that the velocity shall be measured at a height of 36 in. above the floor, Mr. Nobis expressed the opinion that the feet should be protected. As to Section V, relative to Air Quantity, Mr. Nobis was not entirely in agreement with the reference to 10 cu ft. He suggested also that the point at which the recirculated air is taken should be specified. He said it should not be taken at the floor, and recommended that the floor be impervious, that is, of some solid substance.

Mr. Aeberly outlined three factors which he considered to be relatively important, namely, (1) the present day scientific knowledge of what constitutes good ventilation standards, (2) that to the best of our everyday scientific knowledge we can arrive at a semi-ideal practice to convey a thought, and (3) the other man's viewpoint. Mr. Aeberly also suggested that in considering the report it be analyzed in its broadest sense and the various parts properly correlated.

M. G. Harbula stated that he thought the members should have more time to read over the report and correlate everything in it.

G. E. Otis opined that while the report in the present form was very commendable, there were a number of things which on first reading might be improved, such as, for example, the matter of diffusion. It was his opinion that if temperature is the paramount factor, then in obtaining distribution the temperature should be the governing factor rather than carbon dioxide. Mr. Otis also took exception to Section V with respect to specifying a definite quantity of air.

Professor Yaglou stated that in his opinion the code complies with the scientific data at present available. He thought that the air quantity could be established on the basis of the minimum quantity necessary to maintain the atmosphere in an acceptable condition and to prevent the accumulation of moisture in the air. He pointed out that it did not matter how this air entered the room, that is by infiltration or by means of fans, but stated that he had some data, which as yet are incomplete, which would tend to prove that 10 cu ft of air per person per minute is the minimum quantity.

Mr. Aeberly drew attention to the fact that certain people who have given this matter some thought have specified allowable limits to which the partial pressure of oxygen in a space where human beings are housed may be increased beyond which it is unsafe. He said that a much smaller air supply from outside is needed in order to maintain that balance than is represented by the 10 cu ft per minute, but advised that when in doubt, not to go too far away from standard practice.

C. H. B. Hotchkiss asked a number of questions. He wanted to know if it was intended that this report would eventually be a code. He did not understand what was meant by the statement in the Preamble referring to "buildings for which ventilation requirements are to be established." As to the reference in Section I to comfortable effective temperature, he inquired as to whom the effective temperature is to be comfortable. He asked for the authority for the velocity of 50 fpm under the section on Air Motion. Referring to the air quantity of 10 cu ft per minute, Mr. Hotchkiss supposed that this meant 10 cu ft of air actually delivered into the building, because he said it was a fact that a good many plants do not supply 10 cu ft per minute even though it was the intention of the designer that this amount be supplied. Mr. Hotchkiss also inquired as to

how it was decided that such standards were required and could be established.

J. I. Lyle wanted to know if the code was intended for industrial work. He maintained that there are many industries that require humidities above 60 per cent. He said that there are many industries where there is no source of contamination of the atmosphere and where high humidities are desirable and necessary for the product. President Carrier replied that the report was intended to apply to places in which the only source of contamination was the occupants, the idea being that the heat from the machines and effects from the products would be considered contamination. He further stated that the committee agreed that the standards should not apply to processes.

Mr. Driscoll said that it was the committee's idea that where these conditions—noxious odors, fumes or other sources of contamination including excessive temperatures—are created and emanate from sources other than from human beings, they shall not be considered as coming within the scope of this report. President Carrier thought that this point might be made a little clearer.

W. L. Fleisher criticized what he considered to be the loose use of adjectives such as satisfactory, adequate, good, efficient, etc.

C. W. Brabbée, while agreeing to Mr. Fleisher's criticism, said that the other side must also be considered. He pointed out that heating is a fixed science, whereas ventilation is an art, and that an art needs wide limits. Dr. Brabbée thought that Mr. Lyle's point was well taken because, for instance, spinning mills require a very high humidity. Dr. Brabbée also expressed the opinion that, aside from these minor points, the committee has done a wonderful work, not that what is in the report is so excellent, but what is not in it. The big point, he said, was not to throttle an art which is in development by endeavoring to be too specific.

Referring to Section III, T. M. Cunningham inquired as to how objectionable drafts could be measured. F. Paul Anderson alluded to the fact that the development of a report of this nature was a most intricate problem, and asked if there was any one present who could make a code that would be acceptable to everybody, implying that it could not be done. He said that practically all the points that had been raised at the meeting had been considered by the committee. He drew attention to the fact that all of the great documents of the world, such as the Ten Commandments, are exceedingly short and comprehensive, and must be subject to interpretation. Dean Anderson said that the five elements included in this report are the only ones that could be considered in the question of good ventilation. Answering the question of Mr. Hotchkiss regarding comfortable effective temperature, Dean Anderson stated that a very wide range is given. Data were available, he said, which would tend to indicate that 10 cu ft of air per person per minute from the outside is a minimum amount. The Dean also explained that it was the purpose of the committee to submit objectives without any attempt to describe the processes by which these objectives should be attained. He insisted that it was not the intention of the committee to establish fixed methods of accomplishing these things. Referring to Mr. Lyle's remarks regarding the matter of processes, Dean Anderson explained that it was the intent of the report to apply to spaces where the human being is the sole source of contamination.

Dean Anderson paid tribute to E. V. Hill whose recent editorial had pointed the way to the committee to get down to fundamentals. The purpose, as Dean Anderson saw it, was for the Society to accept this report not as a standard to go into effect immediately, but simply as a statement of the art and what should be accomplished by good ventilation. Dean Anderson did not agree with a previous statement that the adjectives referred to were loose words. He said that these words were used purposely to give the engineer a wide range so that he would have an opportunity to determine what was satisfactory, putting in such limits in a few cases that would prevent such absurdities as 100 per cent recirculation. As to drafts, he said, they were just as indefinite as beauty. He requested that the Society take this report simply as a comprehensive statement of the general principles of ventilation, that it be sent to the members, and that every man write his ideas as to what he thinks represents good ventilation.

E. Q. Cole referred to a statement to the effect that there was evidence to prove that the minimum quantity of outside air should be 10 cu ft per person. Professor Yaglou explained that this information had been obtained at the Harvard School of Public Health, and that he would be glad to demonstrate the results to any who doubted the data. Professor Yaglou referred to the effect of occupying a hermetically sealed box and stated that while the temperature problem was not serious, the question of moisture accumulation was to a large extent the governing factor. He explained that he had the data with him but did not want to give it out until he had had an opportunity to make additional experiments to more definitely establish the results.

Professor Yaglou added that he had submitted the data to the Committee on Ventilation Standards with the understanding that it is not for publication for the time being, but that he hoped within a year to have completed results. Dean Anderson thought that Professor Yaglou had not made it entirely clear as to why 10 cu ft of air per minute is a minimum, and Professor Yaglou explained that for temperatures below 70 F one is not comfortable on account of the humidity rise. He also said that one could not smell the air in this hermetically sealed box, but if one could, one would not stay there longer than three quarters of an hour.

Mr. Hotchkiss and Professor Yaglou engaged in a discussion concerning the removal of the moisture coming from the human body. Professor Yaglou explained that with a complete air-conditioning unit, 10 cu ft of air are required per person in order to be able to circulate and distribute the air in the room. He further explained that the data upon which he was working were entirely experimental and probably would not appear in print for about a year.

Mr. Cole did not think the experiments conducted at the Harvard School of Public Health entirely fit the question, but said that the bearing they have on the proposed report was of interest. He asked if it wouldn't be sufficient to simply specify the humidity content of the air, and not insist that it be done by bringing in 10 cu ft per person with the ventilating apparatus.

J. D. Cassell thought this was an unfair question to ask Professor Yaglou who did not prepare the report. Dean Anderson said it did not make any difference whether the air comes in through the ventilating system or through infiltration around the windows. Mr. Cole thought that if the 10 cu ft of air per person is to remain in the report, it should be made clear that it need not be supplied by the ventilating system but be specified to keep down the humidity content of the air to the proper degree, and can be accomplished by any available means. Mr. Otis said he realized that a report of this nature must necessarily include certain empirical quantities, and thought that the question of 10 cu ft of air per person was a very complex matter. He suggested, in view of a remark by Mr. Aeberly, that if it is felt that the problem is one of oxygen pressure, that the minimum oxygen pressure should be stated. President Carrier stated that Mr. Aeberly said it was not a question of minimum oxygen pressure, and Mr. Aeberly interjected with a statement to substantiate Mr. Carrier's remark, and further added that oxygen pressure was only one of the factors to be considered.

Mr. Otis was obdurate, and while he appreciated that one cannot stay in a room forever without supplying new air, because of oxygen, humidity and other factors, he did not think that a specific stipulation as to air quantity should be made unless it can be proved mathematically. Dean Anderson asked Mr. Otis if he would like to see a code adopted with no minimum requirements for air quantity, to which Mr. Otis replied that he would. Dean Anderson then said that Mr. Otis could have the privilege of contending for his point of view so far as omission of reference to air quantity is concerned, when the matter comes up for consideration. Mr. Otis thought it was sufficient to state that the quantity of air used to ventilate a given space during occupancy shall be that necessary to maintain the standards of air temperature, air quality, air motion and air distribution specified by the report. Dean Anderson then said that the committee had been obtaining information from every possible source, and from all the data that were available it seemed that 10 cu ft per person was the minimum.

President Carrier asked Mr. Otis if he would like to make a motion to eliminate reference to the 10 cu ft, and Mr. Otis amended the original motion to eliminate this particular reference. Mr. Driscoll said the motion was out of order because there was a motion before the house, but President Carrier pointed out that this was an amendment to the motion. Mr. Driscoll said the motion was to be sent out for a mail ballot, and suggested that the motion as originally made should use the word *received* rather than *accepted,* that is that the *report be received and sent to the membership for vote of adoption.* He said that receiving the report at the present meeting does not accept any part of it, and that he thought it unwise to accept or amend the report in its present form until it had gone before the members of the Society with the discussions that have been submitted at the meeting, so that the members would have an opportunity to consider all angles and to vote intelligently on the report.

Mr. Otis replied that he would withdraw his motion and Mr. Aeberly accepted the corrected motion. J. D. Cassell presented a motion to amend the original motion that the report sent to the membership be accompanied by the Appendix. Mr. Driscoll said that this was intended, and Mr. Cassell therefore withdrew his amendment.

Thornton Lewis submitted a question concerning Section IV on Air Distribution. He wanted to know whether it was the intention of the committee to limit the variation in the carbon dioxide and not limit the quantity of carbon dioxide in any way. Mr. Driscoll replied "yes." Dean Anderson explained that the variation in the carbon dioxide content is to be used as a measure of circulation and nothing else.

Perry West called attention to a statement in the Preamble to the effect that the report is based on the present available knowledge, regardless of what may be said as to the inadequacy of the available information. It seems to be generally agreed, he said, that a certain amount of air from outdoors is required in order to have satisfactory air conditions within a building, the main question being the exact amount required. Mr. West explained that from all of the available information the minimum amount is between 8 and 10 cu ft per minute per person and he was firmly of the opinion that it would be a mistake to set up standards without establishing a minimum quantity of outside air to be introduced.

For the purpose of clarifying certain points which seemed to be misunderstood, Mr. Aeberly stated that the report consists of five sections, each of which begins with what might be termed an enabling statement, and the subsequent paragraphs of each section are for the purpose of regulating the enabling paragraph.

Mr. Driscoll referred to a question by Mr. Hotchkiss regarding the source of the demand for these standards, and it was explained that there had been a somewhat insistent demand from various sources prior to the Annual Meeting of the Society at Pittsburgh, January 1931, and the matter was crystallized at that meeting by a resolution which was adopted asking for the appointment of a committee to undertake a specific task. Mr. Driscoll said that the impression had been conveyed that the code or standard was to be for legislative purposes, and that this was not the purpose of the report. Mr. Driscoll also alluded to the phrase "for which ventilation regulations are to be established" to which exception was taken by Mr. Hotchkiss. This, Mr. Driscoll explained, was so worded as to avoid the necessity of endeavoring to include every building which in turn would necessitate dividing buildings into groups and indicating those to which the standards established would apply, and those to which they would not apply. To simplify matters, it was therefore stated that these standards are for buildings for which regulations are to be established.

The question of adjectives, Mr. Driscoll said, was replied to very fully by Mr. Aeberly. As to Thornton Lewis' question regarding variation in the concentration of carbon dioxide, Mr. Driscoll suggested the inclusion of the word *total* to modify the word variation, thus making it *total variation,* but this, he said, was a matter for the continuing committee to decide after it had reviewed the discussion which had taken place at the present meeting.

As to the matter of draft, which had been questioned by Mr. Hotchkiss, Mr. Driscoll said that a velocity of 50 fpm had been specified and that this may or may not

be considered a draft, depending upon the individual, but this maximum value was decided upon because it was the opinion of the members of the committee, as the result of their own experiences and the results of a reconciliation of views, that this was the proper limit.

Mr. Driscoll referred to a statement to the effect that the report had not been submitted in time to give those present at the meeting an opportunity to digest it thoroughly. He said that the time required to discuss the matter of specifying 10 cu ft of air per minute per person was as much responsible for this delay as any other factor. The 10 cu ft was adopted because of the experiences of the members of the committee and such scientific data as were available, such as the figures supplied by Professor Yaglou. Mr. Driscoll emphasized the fact that the primary object of the committee was to crystallize the various ideas and viewpoints of the members and to submit them to the Society for consideration.

President Carrier called for the question. Mr. Otis withdrew the motion he had made regarding certain details of the code with the understanding that there would be an opportunity to amend the code at some future meeting. President Carrier replied that a code was always open to amendment, and Mr. Driscoll said that there was no need of rushing the matter through without giving it due consideration. He thought it was too important a matter to rush it through without giving the members of the Society an opportunity to go over the report and the discussions and to express themselves at another meeting of the Society.

Mr. Aeberly and his seconder withdrew the original motion regarding the question of the mail ballot, substituting that the report come up at the next Semi-Annual Meeting of the Society for a vote.

Mr. Hotchkiss inquired as to whether these discussions would be submitted as a summary or as a verbatim report. Mr. Driscoll said that he believed a summary would be better, but that this was a matter for the Council to determine because of the cost of the printing, etc.

Dean Anderson submitted a substitute motion—that the report be received. Mr. Aeberly seconded the motion. The motion was carried.

Mr. Driscoll moved that a new committee be appointed by the incoming president of the Society to give consideration to the discussion and information presented at the present meeting, that this committee be provided with the verbatim record of the discussions, that the committee amend the report if in its judgment it is advisable to do so, and that the report as amended be printed and submitted to the membership for a discussion at the Semi-Annual Meeting 1932. The motion was seconded by Mr. Otis and carried. Mr. Driscoll said that the question of mail ballot would be deferred until after the Semi-Annual Meeting.

Sixth Session—Friday, January 29—10:00 A. M.

The first paper on the program at this session was entitled A Study of Intermittent Operation of Oil Burners, by L. E. Seeley and J. H. Powers. This paper is the result of research conducted at Yale University in cooperation with the A. S. H. V. E. Research Laboratory and the *American Oil Burner Association*, and was presented by Professor Seeley. (Published in *Heating, Piping and Air Conditioning*, February, 1932, page 138.)

In opening the discussion, President Carrier said that many, no doubt, expected efficiencies of 80 to 85 per cent. He stressed the importance of the effect of draft as pointed out by Professor Seeley.

Professor Kratz read a written discussion by W. H. Severns of the University of Illinois, in which Professor Severns stated, among other things, that some of the statements in the paper appear to be contradictory, such as "that intermittent efficiency curves have a definite character, although the curves obtained by continuous tests at various fuel rates do not." C. W. Brabbée contended that the low efficiencies on reduced loads were very serious. He said that even if the boilers have a very high efficiency in continuous operation, they do not have this efficiency during intermittent operation. Dr. Brabbée also discussed in considerable detail various phases of this study, such as the use of oil burners to supply hot-water in the summer, with the consequent decrease in efficiency, the comparison between up-draft and down-draft furnaces, the losses through boiler insulation and through the stack, etc.

H. M. Hart disagreed with a statement by Professor Seeley to the effect that both the intermittent and continuous types of burner should be set to operate at the highest efficiency. This, he said, was true with the intermittent type of burner, but not necessarily so for the continuous operating burner for reasons which were apparent to him from Fig. 1 of the paper.

F. W. Hvoslef said that while it was true that a firebox draft of 0.02 in. is ideal for operation in a laboratory, this amount of draft is not sufficient for practical conditions in the field. He added that there are many hours during the heating season when the burner is operating with zero efficiency, that is, with no output, and that at one time he had figured that as much as 2000 gal of oil would be consumed per heating season in an ordinary residence merely to keep the burner going. Mr. Hvoslef took exception to the statement that a burner could operate just as satisfactorily under pressure control as with thermostatic control. His studies, he said, indicated that oil burning boilers should be smaller than those selected for burning coal.

Percy Nicholls commented briefly on this paper at President Carrier's request. Mr. Hart stated that one of the speakers had left the impression that a continuous operating burner might be more extravagant in fuel consumption. He pointed out that there were two factors to be considered, namely, the burner itself and the application of the burner to the requirements of the heating system. His experience, he said, was the reverse of that of the speaker to whom he referred, excepting in mild days when it is desirable to open windows to let this mild air into the house.

President Carrier seconded Mr. Hart's statement and said that there was a necessary correlation between the burner and boiler. G. L. Larson called attention to the fact that nothing had been said about the amount of brick work or the shape of the combustion space, which would have a great deal to do with the efficiency of the plant as a whole. He inquired if any work had been done along this line.

Referring to the losses in the stack due to the draft during the off-period, W. J. King thought it might be interesting to segregate that loss from the total loss to ascertain how much it actually amounted and whether it is of sufficient value to reduce or eliminate. Homer Addams intimated that the results of this study were in the direction of a small school of boiler designers who had a different idea than the large school and that it seems from this paper and from other experiences that it may be necessary to modify the designs of domestic heating boilers.

In closing the discussion, Professor Seeley requested the slide for Fig. 3 be thrown on the screen. He advised that curve *A* of this figure, which resembles a similar curve in Fig. 1 for a continuous test, was not made with continous burners. This curve, he said, represents the results that would be attained with settings at various points where the draft and combustion were rigidly maintained throughout the entire range of operation.

Professor Seeley agreed with Mr. Hart that the continuous burner might conceivably be more efficient, and that when he mentioned the most desirable setting, he was referring only to the intermittent on-and-off-type of burner with which the desirable setting at maximum efficiency would give the best overall operating result. Professor Severns' criticism, he said, was apparently due to a misunderstanding. He explained that the curve to which Professor Severns referred was a special curve which was included to indicate the results obtained when operating continuously and testing in accordance with the A. S. H. V. E. Code for Testing Steam Heating Boilers Burning Oil Fuel.

Prof. Seeley agreed with Mr. Hvoslef that a draft of 0.02 in. was too low for field conditions, and that it probably would be necessary to have a draft of about 0.05 in. for satisfactory service. Prof. Seeley thought that the question of whether the boiler should be made larger or smaller depends upon its performance. He said that he had intended to conduct some tests with the draft entirely shut off so that no air could flow through the boiler and up the stack and thus carry away the heat, but that he had not had sufficient time to make these tests. Referring to the difference between down-draft and up-draft boilers, Prof. Seeley was of the opinion that if the draft is kept at 0.02 in. it would supply a definite amount of air and that amount of air will flow through the boiler and would, in his opinion, tend to show the same results. The question would be as to whether the draft would remain the same in various types of boilers. Prof. Seeley did not think that the low efficiencies are serious and that any apparatus operating intermittently would show similar results.

President Carrier next introduced A. H. Barker, who presented a paper entitled, Room Warming by Radiation. (Complete paper published in this issue of *Heating, Piping and Air Conditioning,* page 207.) After the presentation by Mr. Barker, Professor Rowley took the chair, and President Carrier discussed certain phases of radiant heating. He said that this method of heating is ideal for certain climatic conditions, both from the standpoint of economy and comfort. He thought this was particularly true of climates such as are experienced in England and in the southern states. Mr. Carrier said that there was a definite relationship between the economy of heating by radiation and the maximum temperature difference, and also a definite relationship between the room temperature and economy. The lower the air temperature and the higher the outside temperature, the greater the economy with this system. One reason for this, he explained, was that the lower the room temperature the smaller the amount of heat required for any air that may be introduced for ventilation purposes. Mr. Carrier then made a mathematical analysis of the subject of thermometry and indicated, among other things, that raising the wall temperature 10 deg and lowering the air temperature 15 deg, would give approximately the same results as with the walls and the air at 70 F. He also made comparisons with other combinations of wall and air temperatures.

A. J. Offner expressed the hope that the paper would start constructive thought on this subject and discussed the commercial and scientific interpretations of the word *radiator*. He called attention to the fact that this word is usually understood to mean a heater placed within a room or building to warm the air. He was of the opinion that a desirable arrangement of heating would be one consisting of more radiation, less convection, lower room air temperatures, and humidity control.

C. W. Brabbée discussed the paper somewhat at length, and outlined some of the difficulties that might be encountered, particularly the space limitations frequently imposed by architects.

A motion by L. A. Harding that the secretary be instructed to extend to Mr. Barker the appreciation of the American Society of Heating and Ventilating Engineers for the presentation of this most excellent and instructive paper, was seconded and carried.

The next paper was entitled Comparison of Performance of Convector Heaters, by A. P. Kratz. (Paper to be published in *Heating, Piping and Air Conditioning,* April, 1932.)

Professor Kratz outlined the experimental apparatus used for conducting these experiments, and stated that various types of convector heaters on the market had been investigated. He added that in all cases the performance of the convector heaters was compared with the performance of a bare radiator, and that the 26-in., five-tube radiator had proved to be the correct size for these comparisons and was used as a standard. The various types of heaters tested were illustrated by slides. One important conclusion obtained from these tests was that these standard types of convector heaters have practically the same heat output as a bare radiator covered with an enclosure and having the same space requirements.

Professor Seeley inquired as to whether a sheet of metal was placed back of the bare radiator and comparative tests conducted. He also asked if in establishing the temperature of 68 F at a 36-in. height, the cooling rate of the room was changed, and thus the wall temperatures. Professor Kratz stated that placing a sheet of metal behind the bare radiator would have some effect on the condensation, but that in this particular case they were interested in comparing the results with the usual setting of the bare radiator and did not use any such sheet of metal in back of the radiator. In answering Professor Seeley's second question, Professor Kratz explained that the size of the radiator was adjusted to take

care of the heat loss from the room when the outside conditions were maintained constant.

Mr. Barker was desirous of being informed as to why the electrical method of heat input was not adopted, to which Professor Kratz replied that steam would have to be generated in some way, and since they had found it more convenient and accurate to use the steam method, this means was employed. Mr. Barker stated that his objection to the use of steam was that it was extremely difficult to determine when it was saturated and did not carry any trace of water. He said that it had been his practice to superheat the steam by means of a gas oven, but that he had always distrusted the results obtained by this method. He inquired of Professor Kratz as to whether any difficulty had been encountered in determining the degree of saturation of the steam. Professor Kratz stated that the steam was superheated about one degree with a small electric heater placed before the radiator, and they had had no occasion to distrust their results. He added that they had been able to duplicate their external conditions very closely and that any results that are not duplicated within two per cent are discarded. He admitted that there were arguments to be advanced for both methods but that they had developed the technique of the condensation method and the main reason for using it was that it was more convenient for them to do so.

F. D. Mensing wanted to know the temperature in the space below the test room and the temperature in the space above this room, and why these temperatures were maintained. Professor Kratz replied that the temperature of the space above the room was 62 F, which temperature, he said, was maintained because this is practically the temperature existing at or near the floor of an intermediate story. He said there was some doubt as to the probable temperature underneath the floor, and that their main object was to conduct the tests so that there would be practically no heat flow through the floor. In order to secure this condition, the temperature difference between the thermocouples on the top and lower surfaces of the floor was maintained at one degree.

The next paper scheduled for the program was that entitled A Study of the Combustible Nature of Solid Fuels, by R. V. Frost, which was presented by title, owing to Mr. Frost's absence. (Published in *Heating, Piping and Air Conditioning,* September, 1931, page 771.)

The next item of business was the presentation of resolutions which were prepared by a committee of which H. M. Hart was chairman. The following resolutions were adopted:

Resolved, that the members here assembled at the 38th Annual Meeting of the Society extend to the Cleveland Chapter and its Committee on Arrangement and its committee chairman, T. A. Weager, our congratulations on the very interesting and unique program provided for our entertainment.

Resolved, that the Ladies Committee of our 38th Annual Meeting be congratulated for the graceful and cordial manner in which they looked after the comforts of their guests.

Resolved, that the Society express its appreciation to the Chamber of Commerce of Cleveland for its generous entertainment and co-operation during this convention.

Resolved, that the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS here assembled wish to congratulate the Program Committee, the authors and the Technical Secretary of the Society, for the excellent papers prepared and presented at this, our 38th Annual Meeting.

Resolved, that it is the sense of this meeting that we express our appreciation to the City of Cleveland for the use of the Public Auditorium.

Resolved, that the Society express its appreciation to the Exposition Management for the character and magnitude of the exhibits we have been privileged to attend.

Resolved, that we express our appreciation to the press for the generous and helpful publicity given this convention.

Resolved, that the Secretary of our Society be requested to express to the management of the Hotel Statler our appreciation of the excellent accommodations provided and the service rendered during our stay in Cleveland.

Resolved, that we extend our appreciation to the several Cleveland manufacturers and the Goodyear-Zeppelin Company whose plants were thrown open for our visits of inspection.

Resolved, that the Society here represented express by a rising vote of thanks the appreciation of the membership for the fine work done for the Society by our Officers, the Secretary and his staff, Committee on Research and the Laboratory staff during the past year.

Resolutions were also offered by J. F. Hale in behalf of two recently deceased members of the Society, as follows:

Whereas, James H. Davis was a charter and life member of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and

Whereas, Mr. Davis gave much of his time and help in the early developments of our organization, serving on committees and at one time a member of our Board of Governors, and

Whereas, he has passed on to eternal life with Infinite Mind; be it

Resolved, that we in convention assembled do bow our heads in respect for him as a man; and be it further

Resolved, that this resolution be spread upon our records and that a copy be forwarded to his widow and family, that they may know with what high regard we held him.

Whereas J. J. Wilson was a charter and life member of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and

Whereas, Mr. Wilson was a constant attendant at our Society and Chapter meetings since their organization, and

Whereas, this charming character has passed on to a much merited reward, be it

Resolved, that we in this convention assembled do bow our heads in respect for him who took such pleasures in our association, and be it further

Resolved, that this resolution be spread upon our records, that he may be remembered for all time as one of the faithful.

President Carrier called attention to the death of Robert Fry, another active member of the Society, who died last June, and requested those present to bow their heads for a moment in his memory.

The final matter of business was the installation of the newly elected officers by a special committee composed of three past Presidents—L. A. Harding, Buffalo; John F. Hale Chicago, and F. Paul Anderson, Lexington, Ky. The officers elected and installed were as follows:

F. B. Rowley, *President*
W. T. Jones, *First Vice-President*
C. V. Haynes, *Second Vice-President*
F. D. Mensing, *Treasurer*

Council Members: F. E. Giesecke, G. L. Larson, J. F. McIntire, and W. E. Stark.

A View of a Portion of the Second International Heating and Ventilating Exposition in the Auditorium Annex, Cleveland, Ohio, January 25-29, 1932

Second International Heating and Ventilating Exposition

A TRIBUTE to the inventive genius of mankind, the Second International Heating and Ventilating Exposition held at Cleveland Auditorium Annex, January 25-29, 1932, was featured by the most imposing array of heating, ventilating and air conditioning apparatus ever assembled under one roof. It was apparent that the omnipresent Btu, with which the heating and ventilating engineer is so much concerned, had been the object of much thought and contemplation since the first exposition in Philadelphia, January, 1930. All manner of devices, materials and appurtenances for producing, transmitting, subtracting, subjecting and corralling this elusive quantity and its atmospheric environment, were on display.

The attendance not only compared favorably with that of the first Exposition, but the serious interest of the thousands of visitors emphasized the importance with which this Exposition was regarded by the industry. The success of the Exposition was assured from the very opening of the doors.

Exhibitors were especially pleased with the type and caliber of the visitors. Among those who attended were architects, engineers, contractors, manufacturers, building operators and home owners. There were public utility representatives and members of the engineering and architectural staffs of boards of education from all parts of the country. Several groups of professors and students from leading colleges and universities attended, as did owners and managers of theatres, hotels, restaurants, stores and many other places of public assemblage. The visitors included the engineering staff of a large chain of hotels.

It was evident that the public is rapidly becoming *air-minded,* for manufacturers of air conditioning equipment were well represented. These displays included apparatus of both the unit and central station types for the processing of materials and for comfort conditioning. Several outstanding domestic air conditioning units were exhibited, some of which are designed for either winter or summer operation.

Closely allied to the air conditioning exhibits was that of the refrigerating machine manufacturers to whom a large section was devoted. A complete line of air cooling and refrigerating devices involving many new inventions and developments, was shown.

One exhibitor presented apparatus for summer cooling, using ice as a refrigerant, the installation cost of which was said to be comparatively low, and its operating economy especially adapted to such public meeting places as churches where cooling is necessary only once or twice a week.

There was a wide selection of apparatus to cover practically every requirement in the warm air heating field, from the gravity warm air furnace to the completely automatic fan furnace or mechanical air-conditioning unit. Domestic air-conditioning plants designed to supply filtered, washed, heated and dehumidified air, and fan furnace units of large capacities for theatres and auditoriums, were exhibited. Auxiliary equipment

such as humidifiers, blowers, filters and other appurtenances for use in existing heating plants, were included.

Several booths were devoted to the latest designs of, and materials used for, heating units. Improved types of cast-iron radiators and extended surface units for gravity convectors were on display; also radiator covers and shields of attractive and useful design.

Heating specialties for vapor and vacuum systems and the various temperature control devices seemed to attract considerable interest. A new selective vacuum system automatically furnished just sufficient heat to maintain a predetermined indoor temperature, either in an entire building or in zones of the building. Many new and unique radiator traps and valves were shown.

One exhibitor introduced a new gradual-acting central control for an improved system of steam heating. Systems of temperature regulation which provide for daytime and nighttime temperatures or for any other period, and for room or zone control of a building, were exhibited. Other systems featured the control of the temperature of certain radiators in a building from a central control board. There was also a control system which regulates the amount of heat supplied to maintain a given inside temperature according to the outdoor temperature.

Various types of direct control valves for radiators were included, as well as equipment for regulating the temperature of radiators collectively. Electrically controlled devices were much in evidence and included switches, relays, motor-driven regulators, motor-driven valves, thermostats, etc. One exhibit was devoted largely to bi-metallic types of thermostats and correlated systems of temperature regulation. New control devices for the refrigerating field were also presented. A stack safety and ignition control and a low voltage transformer and relay set were shown. Another control was for use in the bonnet of a fan furnace to govern the operation of a fan and to function as a furnace limit switch.

In the pump section, there were also a number of interesting displays. Boiler feed pumps, bilge pumps, condensation pumps and receivers, various types of vacuum pumps, in fact pumps for every heating and ventilating service were included in this section.

The prospective purchaser of boiler equipment perhaps gleaned more information in a single day than he might otherwise have obtained in weeks, as the show was abounding with excellent boiler exhibits. These included round and rectangular cast-iron boilers and steel boilers of the water-tube and fire-tube types. A very attractive and instructive presentation of one boiler manufacturer consisted of a line of cast-iron and steel magazine feed boilers. The display included a steel boiler under fire, using chestnut coke. Another feature was a new combination gas boiler for burning gas in the spring and fall, and coal or coke during the remainder of the heating season. A boiler equipped with a compartment for drying clothes created considerable interest.

New and improved fuel-burning devices were much in evidence. These included mechanical stokers, oil burners, combination oil burners and boilers, and various types of gas-heating appliances. Several exhibits were devoted to automatic stokers for anthracite and bituminous coal and coke.

Practically all types of oil burners were displayed, thus enabling the visitor to select the type of burner best adapted to his particular requirements, whether domestic, commercial or industrial. There were several new oil-burning boilers and oil-burning warm-air furnaces designed to supply conditioned air. The accessory oil burner equipment included a gas adapter for use with natural gas, and a novel oil pump for which a high efficiency and unusual flexibility were claimed. Exhibits of oil burning ranges, particularly the larger sizes, suitable for hotels and restaurants, attracted many prospects. A complete line of gas-heating appliances for practically every heating service was the source of much favorable comment.

Many types of unit heaters were shown, including low- and high-pressure steam, direct gas-fired and units employing the use of electrical resistances. A high-pressure unit heater designed for a pressure of 1,000 lb was exhibited; also a hot water unit for automobiles and a small electric unit heater for use in bath rooms and other small rooms.

Unit ventilators for school and office use occupied an important place among the various exhibits. These included units for total or partial recirculation and units with provision for washing, filtering and humidifying the air before it is introduced into the room.

The fan and blower industry was represented with a wide selection of apparatus for practically all types of heating and ventilating service. Among the fans displayed were those of the radial-flow type including steel plate fans, pressure blowers, etc., and fans of the kinetic type including the so-called multiblade fans. One of the new products was a forced draft apparatus with graduated control which, it was claimed, introduces the proper volume of air at the proper static pressure for efficient combustion. Special fans and blowers for use in connection with fuel-burning devices to obtain better combustion, were displayed.

The increasing use of fans for heating and ventilating work has materially added to the demand for motors. Furthermore, the motor finds an application in nearly every phase of the industry, including stokers, oil burners, pumps, refrigerating apparatus, air filters, ventilation and air-conditioning equipment, etc. The motor manufacturers, not unmindful of the opportunities afforded by the show, presented a wide variety of products. Belting, too, plays an important part in the industry. One of the booths displayed a V-type belt and a new line of pressed steel sheaves available in various diameters and numbers of grooves.

Welding and cutting equipment of various types was offered for consideration. A completely welded piping installation showing some recent developments in the installation of piping attracted considerable attention. One exhibitor illustrated the advantages of using welding in heating and ventilating installations by means of a section of a basement and first floor of a modern dwelling. Another featured welding fittings installed in piping work from which wall sections had been cut away, showing the type of joint secured when using that particular fitting.

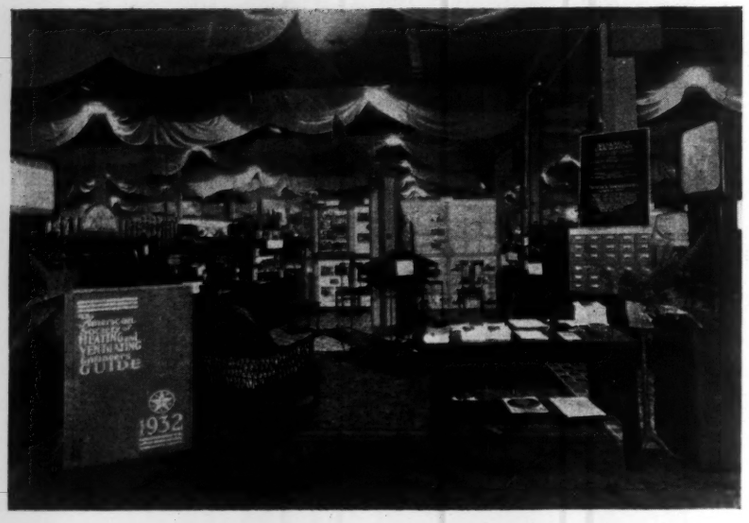
Pipe and fittings also occupied a prominent place at the show. One booth featured a heating installation in actual operation, including the boiler, radiators and the necessary pipe and fittings. Another portrayed a method of making joints and connections without the use of screwed fittings. The pipes were connected to the fittings by soldering through a hole after the pipes had been inserted into the fittings.

Manufacturers of tools, including pipe threading and cutting, wrenches, hammers, etc. were represented. Their booths were especially attractive and many orders for these devices were reported taken. Demonstrations of cutting and threading of pipe created considerable interest. A piece of 4-in. pipe was cut off in 9 sec, and then threaded in 42 sec. A higher speed machine capable of cutting off a 2-in. pipe in 6 sec and threading it in 14 sec, was exhibited.

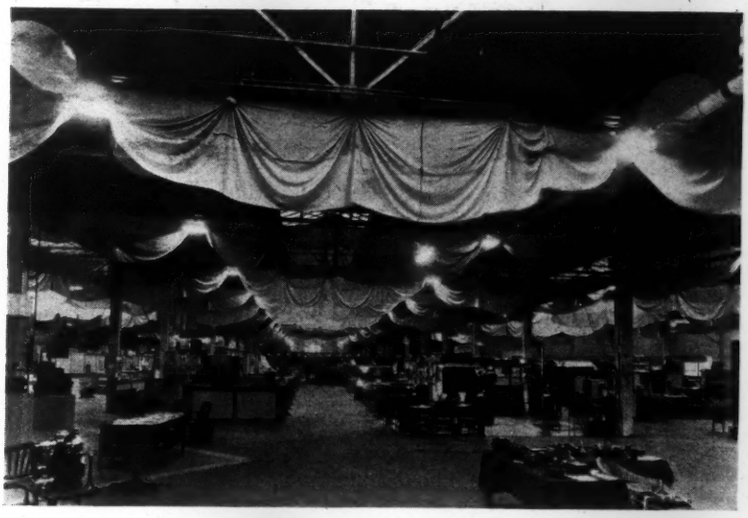
The insulating group included materials for practically all types of service in the building field. Pipe coverings, low temperature insulations and building insulations of all types were exhibited including the so-called fills and the rigid and flexible materials. An insulating material especially adapted to warm air ducts because of its noise-reducing and fire-resisting qualities, was shown.

The exhibits included furnace vacuum cleaners, water circulating pumps for hot water heating systems, boiler protective devices, water heaters of the instantaneous and storage types, grilles, registers and diffusers, window ventilators including filtering and sound-deadening units for eliminating street noises, and many other devices and materials which could not be adequately described in the brief space of this article.

One of the novel features of the show was a robot colored



Views of The Second International Heating and Ventilating Exposition at Cleveland, Ohio January 25-29, 1932



boy of one of the exhibitors, who, by recognizing certain persons in the audience (with the aid of a concealed operator), afforded considerable amusement.

The AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS sponsored a large booth at which information concerning the Society was disseminated. The booth included a very attractive display of apparatus used at the A. S. H. V. E. Research Laboratory at Pittsburgh and at institutions with which the SOCIETY maintains cooperative agreements. Visitors showed genuine interest in the laboratory apparatus and in the results of SOCIETY research work. The apparatus shown included the following:

1. A Benedict-Roth Metabolism Apparatus which is used in heat and moisture studies for determining the total heat production of humans in different atmospheric conditions engaging in different degrees of activity.

2. A balance accurate to 0.1 gram in 500 lb, on which the weight loss by evaporation from human beings is determined.

3. A set-up for determining the heat emission from copper and iron pipe.

4. In the heat transmission field were three displays as follows:

   a. A pyrheliometer, mounted on an equatorial trunnion so as to follow the sun throughout the day and record the intensity of solar radiation, was connected to a galvanometer calibrated in Btu per square foot per hour. Several sources of radiant energy were provided, as were also plates of glass, so that the complete set-up showed the sensitivity of the pyrheliometer and also the absorption of radiant energy by glass.

   b. A Nicholls' Heat Flow Meter connected to a potentiometer hook-up. This apparatus not only displayed the sensitivity of the heat flow meter, but demonstrated the value of the meter for heat flow measurements in both test set-ups and field applications.

   c. The hot plate apparatus as used at the University of Minnesota for determining conductivities of building materials.

5. A pyrotannic detector for determining the carbon monoxide content of air.

6. A recording thermometer.

7. Two slide projecting machines which presented views of the studies at the Research Laboratory and at cooperating universities.

8. Photographs from the A. S. H. V. E. Research Laboratory, University of Illinois, University of Minnesota, University of Wisconsin, Carnegie Institute of Technology, Armour Institute of Technology, Harvard School of Public Health, Yale University, and Agricultural and Mechanical College of Texas.

9. The files of the Association for Correlating Thermal Research.

In addition to the SOCIETY, other associations were represented. The *American Gas Association* occupied a very attractive booth, and the *A. G. A.* Testing Laboratory in another space exhibited views of their Cleveland and Los Angeles laboratories, showing various testing and research set-ups. Approval requirements and other literature relating to the *A. G. A.* Laboratory's activities were on display and distributed to those interested. Other organizations represented were the *American Society of Refrigerating Engineers, American Oil Burner Association, Cleveland Engineering Society, Heating and Piping Contractors National Association, National Warm Air Heating Association, Oil Heat Institute,* and Case School of Applied Science.

The Smoke Inspection Division, Department of Safety of the City of Cleveland, had a most interesting display of diagrams, charts and data relating to the abatement of smoke. This material was gathered from laboratories of municipalities, principally New York City, Pittsburgh, and the U. S. Public Health Service at Washington. The exhibit attracted considerable attention inasmuch as many municipal governments are vitally interested in the elimination of smoke for better health and comfort.

The Advisory Committee of the SOCIETY for the Exposition consisted of Walter Klie, Cleveland, *Chairman;* H. P. Gant, Philadelphia, *Vice-Chairman;* D. S. Boyden, Boston; A. C. Edgar, Philadelphia; C. Gottwald, Cleveland; C. V. Haynes, New York; C. H. B. Hotchkiss, New York; W. C. Kammerer, Cleveland; F. P. Keeney, Chicago; F. A. Kitchen, Cleveland; J. F. McIntire, Detroit; J. C. Miles, Cleveland; H. C. Murphy, Louisville; M. F. Rather, Cleveland; E. A. Scott, New York; W. E. Stark, Cleveland; F. R. Still, New York; T. A. Weager, Cleveland; A. W. Williams, Columbus.

The Exposition was conducted by the International Exposition Company, New York, of which Charles F. Roth is manager, under the auspices of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The following manufacturers and organizations used space at the Exposition:

Adams Bros. Mfg. Co., Inc., 1500 W. North Ave., Pittsburgh, Pa.
Aerofin Corporation, 850 Frelinghuysen Ave., Newark, N. J.
Aerologist, The, 121 N. Clark St., Chicago, Ill.
A. G. A. Testing Laboratory, 1032 E. 62nd St., Cleveland, O.
Air Control Systems, Inc., 2240 N. Racine Ave., Chicago, Ill.
Airgard Ventilator Corp., 250 E. 43rd St., New York, N. Y.
Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y.
Alco Valve Company, Inc., 2628 Big Bend Blvd., Maplewood, Mo.
Allis Chalmers Mfg. Co., Milwaukee, Wis.
American Air Filter Corp., 215 Central Ave., Louisville, Ky.
American Foundry Equipment Co., Mishawaka, Ind.
American Foundry & Furnace Co., Bloomington, Ill.
American Gas Association, 420 Lexington Ave., New York, N. Y.
American Gas Products Corp., 704 Chrysler Bldg., New York, N. Y.
American Oil Burner Association, 342 Madison Ave., New York, N. Y.
American Propeller Co., 401 Bendix Drive, South Bend, Ind.
American Radiator Co., 40 W. 40th St., New York, N. Y.
American Society of Heating & Ventilating Engrs., 51 Madison Ave., New York, N. Y.
American Society of Refrigerating Engrs., 37 W. 39th St., New York, N. Y.
American Temperature Indicating Co., Toledo, O.
American Warming & Ventilating Co., Toledo, O.
Ames Iron Works, Oswego, N. Y.
Ames Pump Co., 30 Church St., New York, N. Y.
Armstrong Machine Works, Three Rivers, Mich.
Auer Register Co., 3608 Payne Ave., Cleveland, O.
Automatic Burner Corp., 1823 Carroll Ave., Chicago, Ill.

B-Line Boiler Co., E. 131st St. and Taft Ave., Cleveland, O
Barber-Colman Co., Rockford, Ill.
Barber Gas Burner Co., 3704 Superior Ave., Cleveland, O.
Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Boston, Mass.
Bishop & Babcock Sales Co., 4901 Hamilton Ave., N. E. Cleveland, O.
Bohn Aluminum & Brass Corp., 2306 Franklin St., Detroit, Mich.
Bonney Forge & Tool Works, Allentown, Pa.
Borden Company, Warren, O.
Breuer Electric Mfg. Co., 844 Blackhawk St., Chicago, Ill.
Bryant Heater & Mfg. Co., 17825 St. Clair Ave., Cleveland, O.
Buckeye Blower Co., Columbus, O.
Building Arts Exhibit, Inc., Builders Exchange Bldg., Cleveland, O.
Burdett Mfg. Co., 19 N. Sheldon Ave., Chicago, Ill.

Capitol Brass Division, 2306 Franklin St., Detroit, Mich.
Carbondale Machine Co., Carbondale, Pa.
Carrier Corporation, 850 Frelinghuysen Ave., Newark, N. J.
Carrier Engineering Corp., Newark N. J.
Carrier-Lyle Corp., 850 Frelinghuysen Ave., Newark, N. J.
Carrier-York Corp., 1541 Sansom St., Philadelphia, Pa.
Case School of Applied Science, Cleveland, Ohio.
W. D. Cashin Co., 69 A St., South Boston, Mass.
Century Electric Co., 1806 Pine St., St. Louis, Mo.
Century Engineering Corp., Cedar Rapids, Iowa
W. M. Chace Valve Co., 1600 Beard Ave., Detroit, Mich.
Chicago Pump Co., 2336 Wolfram St., Chicago, Ill.
Cleveland Engineering Society, Hanna Bldg., Cleveland, O.
Cleveland Gas Burner & Appliance Co., Cleveland, O.
Cleveland Steel Products Corp., Madison at W. 74th St., Cleveland, O.
Cleveland Stoker Co., 6545 Carnegie Ave., Cleveland, O.
Coal Carburetor Co., 290 George St., New Brunswick, N. J.
Columbia Burner Co., Toledo, O.
Columbus Humidifier Co., 1 E. 5th Ave., Columbus, O.
Conco Temperature Control Corp., Detroit, Mich.
Cook Electric Co., 2700 Southport Ave., Chicago, Ill.
Cooling & Air Conditioning Corp., 11 W. 42nd St., New York, N. Y.
Copeland Products Co., Mt. Clemens, Mich.

Coppus Engineering Corp., Worcester, Mass.
Corozone Co., Inc., Hanna Bldg., Cleveland, Ohio
Crane Company, 836 S. Michigan Ave., Chicago, Ill.

Dail Steel Products Co., Lansing, Mich.
Doherty-Brehm Co., 333 N. Michigan Ave., Chicago, Ill.
Domestic Engineering, 1900 Prairie Ave., Chicago, Ill.
C. A. Dunham Co., 450 E. Ohio St., Chicago, Ill.
Dunkirk Radiator Corp., Dunkirk, N. Y.
Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa.

Eagle-Picher Lead Co., Joplin, Mo.
East Ohio Gas Company, 1405 E. Sixth St., Cleveland, O.
Economy Baler Co., Ann Arbor, Mich.
Economy Pumping Machinery Co., 3431 W. 48th Pl., Chicago, Ill.
Emerson Elec. Mfg. Co., Inc., 2012 Washington Ave., St. Louis, Mo.
Engineering Publications, Inc., 1900 Prairie Ave., Chicago, Ill.
Estate Stove Co., The, Hamilton, O.

Fedders Mfg. Co., Buffalo, N. Y.
Fitzgibbons Boiler Co., Inc., 570 Seventh Ave., New York, N. Y.
Forest City Foundries Co., 2500 W. 27th St., Cleveland, O.
Fox Furnaces Co., Elyria, Ohio
Fox Smith Sales Co., Cleveland, O.
Frick Company, Inc., Waynesboro, Pa.
Frigidaire Corp., The, Dayton, O.
Fuel Oil Journal, 420 Lexington Ave., New York, N. Y.

General Air Filters Co., Louisville, Ky.
General Electric Co., 1 River Road, Schenectady, N. Y.
General Electric Heat Regulator Co., Franklin Trust Bldg., Philadelphia, Pa.
General Gas Light Co., Kalamazoo, Mich.
Gilbert & Barker Mfg. Co., Springfield, Mass.
D. H. Gowing, 995 Monroe Ave., Rochester, N. Y.
Greene Gas Cleaner Co., 1600 Union Trust Bldg., Cleveland, O.
Grinnell Co., Inc., Providence, R. I.
Grinnell Co. of Canada, Ltd., 2440 Dundas St., W. Toronto, 9, Ont., Canada

Hanna Coal Co., Leader Bldg., Cleveland, Ohio
Hart & Cooley Mfg. Co., Holland, Mich.
Health Air Systems, Ann Arbor, Mich.
Heating Journals, Inc., 167 Madison Ave., New York, N. Y.
Heating, Piping & Air Conditioning, 1900 Prairie Ave., Chicago, Ill.
Heating & Piping Contractors National Ass'n, 50 Union Sq., New York, N. Y.
Heating and Ventilating, 140 Lafayette St., New York, N. Y.
Henry Furnace & Foundry Co., 3471 E. 49th St., Cleveland, O.
Wm. Highton & Sons, Div. of Hart & Cooley Mfg. Co., Holland, Mich.
E. Vernon Hill Co., 121 N. Clark St., Chicago, Ill.
Hoffman Specialty Co., Inc., Waterbury, Conn.
Hotstream Heater Co., 7800 Finney Ave., Cleveland, Ohio
Humidity Control Co., 303 Bernice Bldg., Tacoma, Wash.

Illinois Engineering Co., Racine Ave. at 21st St., Chicago, Ill.
Independent Air Filter Co., Inc., 29 S. Clinton St., Chicago, Ill.
Independent Register & Mfg. Co., 3747 E. 93rd St., Cleveland, O.
Iron Fireman Mfg. Co., Portland, Ore.

Johns-Manville Corp., 292 Madison Ave., New York, N. Y.
S. T. Johnson Co., 940 Arlington Ave., Oakland, Calif.
Johnson Service Co., Milwaukee, Wis.

Keasbey & Mattison Co., Ambler, Pa.
John G. Kelly, Inc., 210 E. 45th St., New York, N. Y.
John R. Kelly Co., 213 N. Ball St., Owosso, Mich.
Kelly-Robbins Mfg. Co., Owosso, Mich.
Kewanee Boiler Co., Inc., 570 Seventh Ave., New York, N. Y.
Kewanee Boiler Corporation, Kewanee, Ill.
Kieley & Mueller, Inc., 34 W. 13th St., New York, N. Y.
Kleenaire Filter Co., Stevens Point, Wis.
Kleen Heet, Inc., Chicago, Ill.
Knowles Mushroom Ventilator Co., 41 N. Moore St., New York, N. Y.

Lakeside Company, Hermansville, Mich.
Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.
The Linde Air Products Co., 205 E. 42nd St., New York, N Y.

McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich.
J. H. McCormick & Co., Lewis Tower, 30th Fl., Philadelphia, Pa.
McDonnell & Miller, Wrigley Bldg., Chicago, Ill.

Jas. P. Marsh & Co., 2073 Southport Ave., Chicago, Ill.
Masonite Corp., 111 W. Washington St., Chicago, Ill.
Massachusetts Blower Co., Cleveland, O.
May Oil Burner Corp., 3500 E. Biddle St., Baltimore, Md.
The Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Midwest Mfg. Co., Bradford, Pa.
Mineral Felt Insulating Co., 2284 Albion St., Toledo, Ohio
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Modern Building Insulators of Cleveland, Inc., 5606 Euclid Ave., Cleveland, Ohio
Modern Heat Regulator Co., 1781 E. 55th St., Cleveland, O.
Modine Mfg. Co., Racine, Wis.
Monarch Mfg. Works, Inc., Salmon and Westmoreland Sts., Philadelphia, Pa.
Motor Stokor Corp., 250 Park Ave., New York, N. Y.
Motor Wheel Corp., Lansing, Mich.

Mouat Vapor Heating Co., 1246 W. 4th St., Cleveland, O.
L. J. Mueller Furnace Co., 339 S. Second St., Milwaukee, Wis.
Mueller Brass Co., Port Huron, Mich.
Multicell Radiator Corp., West Ave., Lockport, N. Y.

Nash Engineering Co., South Norwalk, Conn.
National Air Filter Co., Inc., 205 Central Ave., Louisville, Ky.
National Warm Air Heating Assn., 50 W. Broad St., Columbus, O.
Herman Nelson Corp., Moline, Ill.
Newport Boiler Div. Richardson & Boynton Co., 244 Madison Ave., New York
Niagara Blower Co., 6 E. 45th St., New York, N. Y.

Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, O.
Oil Heat, 167 Madison Ave., New York, N. Y.
Oil Heating Institute, 342 Madison Ave., New York, N. Y.
Owens-Illinois Glass Co., Toledo, O.
Oxweld Acetylene Co., 30 E. 42nd St., New York, N. Y.

Parker Appliance Co., 10320 Berea Road, Cleveland, O.
Parks-Cramer Co., Fitchburg, Mass.
Patrol Valve Co., Locust Ave. and W. 114th St., Cleveland, O.
Peerless Electric Co., Warren, Ohio
Peerless Unit Ventilation Co., Inc., 776 Union Ave., Bridgeport, Conn.
Penn Electric Switch Co., 20th and Walnut Sts., Des Moines, Iowa
Penn Heat Control Corp., 20 S. 15th St., Philadelphia, Pa.
Pennsylvania Furnace & Iron Co., Warren, Pa.
Perfection Stove Co., 7609 Platt Ave., Cleveland, O.
Petroleum Heat & Power Co., Stamford, Conn.
Pierce, Butler & Pierce Mfg. Corp., 41 E. 42nd St., New York, N. Y.
Pittsburgh Coal Co., Pittsburgh, Pa.
Plumbing & Heating Contractors Trade Journal, 515 Madison Ave., New York
Pocahontas Fuel Co., Cleveland, Ohio
Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill.
Preferred Utilities Mfg. Corp., 33 W. 60th St., New York, N. Y.
Propellair, Inc., 17 S. High St., Columbus, O.

Rawlplug Co., Inc., 98 Lafayette St., New York, N. Y.
F. I. Raymond Co., 629 N. Washington Blvd., Chicago, Ill.
Reed Air Filter Co., Inc., 215 Central Ave., Louisville, Ky.
Richardson & Boynton Co., 244 Madison Ave., New York.
The Ric-Wil Co., 1562 Union Trust Bldg., Cleveland, O.
H. H. Robertson Co., Grant Bldg., Pittsburgh, Pa.
Robbins & Myers Gas Appliances, Inc., Springfield, O.
Rochester Circulator Sales Div., 3092 Culver Road, Rochester, N. Y.
Round Oak Furnace Co., Dowagiac, Mich.
W. A. Russell & Co., 5039 Grand Central Term. Bldg., New York, N. Y.
Ruud Manufacturing Co., 29th and Smallman Sts., Pittsburgh, Pa.

Safety Equipment Service Co., 1228 St. Clair Ave., N. E., Cleveland, O.
Sarco Co., Inc., 183 Madison Ave., New York, N. Y.
L. R. Shaw Refractories & Equipment Co., 5716 Euclid Ave., Cleveland, Ohio
H. M. Sheer Co., Quincy, Ill.
Silica-Gel Corp., Baltimore Trust Bldg., Baltimore, Md.
Skidmore Corp., St. Joseph, Mich.
Smoke Inspection Div., Dept. of Pub. Safety, City of Cleveland
Spencer Heater Co., Williamsport, Pa.
Stay-Rite Co., Inc., 1250 W. Fourth St., Cleveland, O.
Steel & Tubes, Inc., Unit of Republic Steel Corp., Cleveland, Ohio
Sun Radiator Cover, Inc., 7802 Carnegie Ave., Cleveland, O.
Surface Combustion Corp., 2375 Dorr St., Toledo, O.
Swartwout Co., 18511 Euclid Ave., Cleveland, O.

Taco Heaters, Inc., 342 Madison Ave., New York, N. Y.
Webster Tallmadge & Co., Inc., 50 Church St., New York, N. Y.
Textor Co., Louis C., Cleveland, Ohio
Time-O-Stat Control Co., Elkhart, Ind.
Timken Silent Automatic Co., 100-400 Clark Ave., Detroit, Mich.
Toledo Pipe Threading Machine Co., Toledo, Ohio
H. O. Trerice Co., 1420 W. Lafayette St., Detroit, Mich.
Tuttle & Bailey Mfg. Co., 155 E. 44th St., New York, N. Y.

Uni-Flo Grille Corp., 4646 Lawton Ave., Detroit, Mich.
Union Carbide Co., 205 E. 42nd St., New York, N. Y.
United States Hame Co., 135 Tonawanda St., Buffalo, N. Y.
United States Radiator Corp., Detroit, Mich.

Voss, Inc., J. H. H., 408 Concord Ave., New York, N. Y.

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Warm Air Furnace Fan Co., 6545 Carnegie Ave., Cleveland, O.
Warm-Air Heating, 105 S. 9th St., St. Louis, Mo.
Watts Regulator Co., Lawrence, Mass.
Warren Webster & Co., Camden, N. J.
Weil-McLain Co., 641 W. Lake St., Chicago, Ill.
Will-Burt Co., Orrville, Ohio
L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y.

York Ice Machinery Corp., York, Pa.
York Oil Burner Co., York, Pa.
Young Radiator Co., Racine, Wis.
Young Ventilating Co., 2703 Woodland Ave., Cleveland, Ohio
Youngstown Sheet & Tube Co., Youngstown, Ohio

F. Paul Anderson Medal Awarded to W. H. Carrier

At the 38th Annual Banquet of the A. S. H. V. E., Hotel Statler, Cleveland, Ohio, January 28, 1932, Willis H. Carrier, President of the Society, received the first award of the F. Paul Anderson gold medal, "for distinguished scientific achievements in the field of heating, ventilating and air conditioning." The presentation was made for the Committee of Award by L. A. Harding, Buffalo, New York, Past President of the Society:

Owing to the unavoidable absence of Prof. A. C. Willard, chairman of the Committee on Award of the F. Paul Anderson Medal, the very pleasant duty and honor of presenting the first medal to be awarded by this Society has devolved upon the speaker.

You have been made fully conversant with the history of the medal and the conditions surrounding its award for the year, 1931, through the last September issue of the JOURNAL of this Society.

The medal is given by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in recognition of work done and meritorious services performed in the field of heating, ventilation or air conditioning.

The first award of this medal is made to a fellow member whose outstanding work and achievements in *all* of the three mentioned fields of endeavor are so well and favorably known both in the United States and foreign countries, that it would seem almost superfluous on my part to remind you of even a few

of his major accomplishments. I refer to the gentleman, scientist and engineer, Willis H. Carrier.

No appreciation that I could express can possibly add to the esteem and veneration with which he is held by his manifold friends and associates. History records but few men of scientific attainment who have combined research, invention and a successful business career. This, he has done.

Mr. Carrier's contributions to the field of heating and ventilation began very soon after his graduation from Cornell University in 1901.

As research engineer and later as the chief engineer of a nationally known corporation, he conducted tests and published the first scientifically conceived rating tables for blast heaters. The basic method he devised remains today the standard by which all types of indirect radiation are rated.

Early in his career he developed one of the first successful methods of conveying comparatively heavy materials by means of air, which was the forerunner of the present pneumatic systems of conveying coal and ashes.

He applied his genius to the improvement in the design of ventilating fans, blowers, blast radiation and centrifugal pumps.

Mr. Carrier, although not the first to employ a spray type air washer, was the first apparently to appreciate or realize the great possibilities of this apparatus for the purpose of humidification and dehumidification. He found no existing theory or design formula which could be employed for these purposes.

He set about to apply the principles of thermodynamics and Dalton's law of partial vapor pressures supplemented by original research, which ultimately resulted in the enunciation of his rational psychrometric formula.

He was first to announce and prove the now well known scientific fact that the saturation of air is an adiabatic process.

He produced the first accurate psychrometric chart and heat exchange diagram, and today the design of all air conditioning apparatus employing a liquid as the medium for humidification or dehumidification is based on the original Carrier formulae.

He invented and developed the well known dew-point control now so universally employed in the control of air conditioning apparatus, and founded the corporation which bears his name.

Mr. Carrier's original paper entitled Rational Psychrometric Formula, presented before the *American Society of Mechanical Engineers* in 1911, is considered one of the classics of that Society and has been translated in many languages.

He has been a contributor to the TRANSACTIONS of this Society since 1918, as well as serving on numerous committees.

His advice and counsel concerning matters of research to the various past directors and present director of this Society's Research Laboratory are acknowledged to have been of the utmost importance to its success. He has contributed many articles to technical journals dealing principally with air conditioning problems.

Mr. Carrier represented both the *American Society of Refrigerating Engineers* and this Society at the World Engineering Congress held in Japan in 1930, at which time he read a paper entitled, The Control of Humidity and Temperature as Applied to Manufacturing Processes and Human Comfort.

Mr. Carrier is a past president of the *American Society of Refrigerating Engineers* and is best known in the field of refrigerating engineering for his invention and development of the Carrier Centrifugal Compressor.

He was awarded the John Scott Medal in 1931 by the City Trusts of Philadelphia for his inventions and development of apparatus in the field of air conditioning.

He was the unanimous choice of both the Committee on Award and the Council for the F. Paul Anderson Medal.

I here state, without fear of being contradicted, that the name *Carrier* will pass down the lane of engineering history coupled with the appellation, *the father of air conditioning.* Truly, the result of his work has substantially contributed to the comfort, health and happiness of millions of people now living and doubtless will continue to so contribute to unborn millions through centuries to come.

Mr. Carrier is Chairman of the Board of the Carrier Corp., Newark, N. J.; Director, Carrier Engineering Co., Ltd., of London; a member of the *American Society of Mechanical Engineers;* Past President, *American Society of Refrigerating Engineers;* President, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Among the gathering who witnessed the presentation of the medal was F. Paul Anderson, for whom the award is named, Past President of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, former Director of its Research Laboratory and Dean of the College of Engineering, University of Kentucky, Lexington, Ky.

F. Paul Anderson was born February 10, 1867, at South Bend, Indiana, was educated in the local schools and graduated from Purdue in 1890 with the degree of Bachelor of Mechanical Engineering and received the degree of Mechanical Engineer in 1894. Following graduation, he was a designer of special machinery for the Studebaker Co., and started his teaching career in 1891 at the State College of Kentucky, now the University of Kentucky. Dean Anderson specialized in experimental work, principally in steam and railway engineering, and his laboratories at the university show the outstanding imprint of his ability as an organizer and executive. Many of the men who have received the teaching and counsel of Dean Anderson have achieved success in many fields, of which heating and ventilating has enjoyed a generous share.

The Committee on Award consisted of Prof. A. C. Willard, University of Illinois, Urbana, L. A. Harding, Buffalo, N. Y., W. T. Jones, Boston, Mass., Thornton Lewis, Newark, N. J., F. C. McIntosh, Pittsburgh, Pa., and Prof. F. B. Rowley, University of Minnesota, Minneapolis Minn.

Sixth Chicago Power Show

The 6th Chicago Power Show, sponsored by the Midwestern Engineering Exposition, Inc., is scheduled for Chicago during the week of June 25-30, 1933, at the Coliseum Buildings.

This show should be of importance to all power equipment manufacturers, because it will be held during the first month of the Chicago World's Fair. Arrangements have been made to set aside the week of June 25 as *Engineers' Week* at the Fair. In accordance with this plan, there will be national meetings of a large number of engineering societies, possibly as many as thirty holding their annual meetings during this particular week.

Entertainment at Cleveland Meeting

MANY enjoyable entertainment features were arranged for the members and guests attending the Annual Meeting of the Society, Cleveland, Ohio, January 26-29, 1932. Nothing more could have been desired, and all were of the opinion that the local committee had anticipated every possible wish.

A joint dinner meeting of the Councils of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *American Society of Refrigerating Engineers,* and their wives, was held on Monday evening, January 25, 1932 at the Hotel Cleveland. This was a most enjoyable occasion for a reunion of old friends.

An informal reception including musical entertainment and Monte Carlo was held on the mezzanine floor of the Hotel Statler, Tuesday evening. The fact that the guests lingered until the *wee* small hours was evidence of the good time they enjoyed. As an additional feature, a vaudeville show was given, and those who attended were unanimous in proclaiming their approval. Unique paper hats and favors were distributed.

There was no technical session on the afternoon of Wednesday, January 27, 1932, but a trip to Akron, Ohio, to inspect the Goodyear-Zeppelin Hangar was provided by the committee. This was a joint affair with the *American Society of Refrigerating Engineers,* and was most enlightening. This hangar was that in which the U. S. government dirigible Akron was built.

The annual dinner for past-presidents was given in the Tavern Room of the Hotel Statler at 7:00 p. m. on Wednesday, January 27, 1932. This dinner was attended by 14 past-presidents of the Society, including Homer Addams, F. P. Anderson, S. E. Dibble, W. H. Driscoll, H. P. Gant, J. F. Hale, L. A. Harding, J. D. Hoffman, H. M. Hart E. V. Hill, S. R. Lewis, Thornton Lewis, J. I. Lyle and J. R. McColl. On this occasion neophyte Harding was initiated into this exclusive and highly respected organization. The dinner of the wives of the past-presidents of the Society was given simultaneously with that of the past-presidents in a nearby parlor. Those present were Mrs. W. H. Carrier, *hostess,* Mrs. F. P. Anderson, Mrs. Homer Addams, Mrs. S. E. Dibble, Mrs. J. F. Hale, Mrs. L. A. Harding, Mrs. S. R. Lewis and Mrs. J. I. Lyle.

The same evening a ladies' theatre party was given at Keith's Palace while the gentlemen devoted their time to an inspection of the Second International Heating and Ventilating Exposition in progress at the Cleveland Auditorium Annex.

A ladies' bridge and tea was given at the Chamber of Commerce on Thursday afternoon, January 28, 1932. This affair was given jointly for the ladies of the A. S. H. V. E. and *A. S. R. E.*

The annual banquet and dance was held in the Hotel Statler Ball Room at 7 p. m. Thursday, January 28, 1932. After a sumptuous repast, S. R. Lewis of Chicago, a past-president of the Society, acted as toastmaster. The presentation of the F. Paul Anderson Medal which had been awarded to President W. H. Carrier, was made by L. A. Harding, his predecessor as president of the Society, who outlined in detail the various events in the life of Mr. Carrier for which he is so highly esteemed and for which the medal was awarded. (Full text of speech on page 240).

The address of the evening was delivered by W. E. Wickenden, President of Case School of Applied Science, Cleveland, Ohio, who spoke on The Relation Between the Colleges and Technical Societies. Dr. Wickenden's humor was contagious and the inspiring message that he brought to his audience struck a responsive chord. After Dr. Wickenden's speech, J. I. Lyle presented the past-president's emblem of the Society to Mr. Carrier.

The banquet hall was then cleared and dancing to the strains of one of Cleveland's favorite orchestras took place.

The final event was an inspection trip to Cleveland's industrial plants on Friday afternoon, January 29, 1932.

The entertainment of the Annual Meeting 1932, which was so efficiently provided by the Committee on Arrangements, will long be remembered by those who had the good fortune to be present.

The Committee on Arrangements of the Cleveland Chapter consisted of T. A. Weager, *general chairman;* Finance, Walter Klie, *chairman,* W. E. Stark, H. M. Nobis; Banquet, W. C. Kammerer, *chairman,* C. W. St. Clair, Vincent Eaton; Reception and Registration, C. F. Eveleth, *chairman,* F. A. Kitchen, C. Gottwald; Transportation and Inspection Trips, F. H. Morris, *chairman,* C. J. Deex, J. E. Beyer; Entertainment, R. G. Davis, *chairman,* E. H. Pogalies, S. H. Givelber; Publicity, M. F. Rather, *chairman,* D. E. Humphrey (Akron District), D. F. Keith (*A. S. R. E.*); Bridge Hostesses, Mrs. Walter Klie, Mrs. H. B. Matzen, Mrs. C. F. Eveleth, Mrs. T. A. Weager, Mrs. D. F. Keith, Mrs. C. W. Colby.

Case School Will Hold Air Conditioning Conference

A three-day conference on air conditioning will be held at the Case School of Applied Science, Cleveland, March 17-19, sponsored by the school and the *Cleveland Engineering Society.* The tentative program includes the following subjects: Principles of Air Conditioning; The Unit Process in Air Conditioning; Features in the Design of Air Conditioning Systems; Industrial Air Conditioning and Air Conditioning for Human Comfort.

Midwest Coal Conference to be Held at Lafayette

The Fifth Midwest Bituminous Coal Conference is scheduled to be held at Purdue University, Lafayette, Ind., April 14 and 15. Sponsors of the conference, in addition to Purdue University and the University of Illinois, are the *Coal Trade Association* of Indiana, the Illinois Coal Bureau, Fuels Division of the *American Society of Mechnical Engineers,* the *Midwest Stoker Association,* and the *National Association of Power Engineers,* Indiana Branch.

Highlights of 1931 Annual Report of Hudson County Smoke Abatement Bureau

William G. Christy, Chief Smoke Abatement Engineer of Hudson County, New Jersey, has just issued his first Annual Report to the County Board of Health, covering the work performed by his department during the year 1931.

Following are the highlights of the report:

1. Percentage* of smoke density on railroads reduced from 23.5 in May, 1931, to 6.85 in December.
2. Percentage* of smoke violations on locomotives reduced from 34.2 in May, 1931, to 5.8 in December.
3. Percentage* of smoke violations in railroad roundhouses reduced from 75.0 in May, 1931, to 8.2 in December.
4. Percentage* of smoke violations in stationary plants reduced from 18.1 in April, 1931, to 7.0 in December.
5. Percentage* of smoke violations on all classes of fuel burning equipment reduced from 26.3 in May to 7.0 in December.
6. Hudson County Smoke Ordinance is being widely accepted by large cities in many nations as a standard. Recent issue of the magazine, *Power,* contains editorial comment, saying that "The Hudson County Smoke Laws have been generally accepted as the most progressive yet developed, and have been used in a number of instances

*All percentages figured in proportion to number of observations taken.

as a pattern from which to model laws in other localities." The Hudson County Ordinance was drafted by Col. Elliott H. Whitlock, former Smoke Abatement Commissioner of Cleveland and present Smoke Research Professor of Stevens Institute, together with Chief Smoke Engineer Christy.

A. G. A. Distribution Committee Conference

The Ninth Annual Conference of the Distribution Committee, Technical Section, *American Gas Association,* announces a three-day session in Birmingham, beginning April 6, 1932.

A full day has been set aside for the inspection of Birmingham's famous manufacturing plants. Competent guides will be provided and several of the various operations taking place in the plants will be so timed that all attending the Conference will have a chance to view them. Most types of pipe are made in Birmingham. Factory laboratories also will be open to the *American Gas Association* visitors, and they will be permitted to see the latest developments in pipe joints and pipe materials.

Among the principal topics to be discussed at the Conference will be those of change-overs from manufactured to natural gas; service to customers; employee training; pipe joints, pipe coatings and corrosion; unaccounted-for gas; corrosion research as carried on at the U. S. Bureau of Standards, under the auspices of the *American Gas Association* Corrosion Committee and economics of moving, locked and inactive meters. The open forum will be continued this year and it is expected that many engineers who have local problems will take advantage of this opportunity of bringing them before the Conference. All business sessions of the Conference will take place at the Tutwiler Hotel.

Bordering on the natural gas area, Birmingham is expected to attract an unusually large number of natural gas men who will have easy access to that city, which boasts fine transportation facilities from all sections of the United States.

Ninth Annual Oil Burner Show

Plans for the largest show in the history of the oil burner industry are revealed in an announcement of the program for the ninth annual convention and show of the *American Oil Burner Association,* which is to be held in Boston, April 11 to 16, 1932. A full week's activity includes two merchandising and one engineering session, in addition to regularly scheduled meetings for manufacturer members and members of the Dealer Division. Entertainment features also have been scheduled.

Approximately two months before the show is scheduled to open, 59 exhibitors have contracted for 92 booths in Mechanics Hall, Boston, where the exhibits are to be set up. Association officials are confident of a sell-out for the 115 booths on the main floor and have also opened 40 additional spaces on the mezzanine floor to accommodate late-comers.

The show formally opens at 7:30 p. m., Monday, April 11, and is open daily thereafter from 1:30 to 10 p. m. The annual meeting for members, at which the new directors are elected, will be held on Tuesday morning, and the officers will be elected at the meeting of the new Board of Directors on Thursday morning.

A special open meeting for dealers is scheduled for Tuesday afternoon. The activities of the Dealer Division of the Association are expected to draw the largest dealer attendance of any convention in the history of the Association.

The first merchandising session will be held on Wednesday morning, to be followed by an engineering session on Thursday and a final merchandising session on Friday. An outstanding list of speakers has been selected for each session, including Walter F. Tant, president of the *American Oil Burner Association;* Robert Tinsman, president, Federal Advertising Agency; Esten Bolling, consulting engineer on air conditioning; Ralph Bristol, of the Babson Statistical Organization, and Katherine Fisher, of Good Housekeeping Institute.

Death of John J. Wilson

It is with deep sorrow that members learned of the death of John J. Wilson, a charter member of the Society, who was elected to life membership upon his retirement from active business, several years ago.

Mr. Wilson has long been identified with the heating and ventilating profession in Philadelphia, where he was a consulting engineer, and where for the past few years, until his death in December, 1931, he resided at the Hayes Mechanics' Home on Blemont Ave.

It is interesting to note that during the Civil War Mr. Wilson enlisted but was discharged because of his youth and during the World War, at the age of 67, he again offered his services to his country.

On November 18, 1930, the occasion of his 80th birthday, he composed a poem, which appeared in the January, 1931, issue of *Heating, Piping and Air Conditioning.*

At the 38th Annual Meeting of the Society in Cleveland, O., a resolution was offered in behalf of Mr. Wilson, and this appears in the Proceedings of the Meeting in this issue.

Raymond Newcomb Killed in Accident

Friends of Raymond Newcomb were greatly shocked to learn of his death on February 15, 1932, due to an automobile accident near Birmingham, Ala.

Mr. Newcomb was born at Boston, Mass., on July 12, 1897. He was a graduate of Massachusetts Institute of Technology, and took post-graduate work at Stevens Institute of Technology, specializing in boiler design and operation. During the war, he had charge of boiler operations aboard large transports, with the commission of ensign. After the war, he became associated with Kewanee Boiler Co., Inc., and was vice-president of this concern at the time of his death. He was also vice-president of the Fitzgibbons Boiler Co., Inc.

Mr. Newcomb was elected to membership in the Society in 1927, and participated in many Society activities. He served on various Society committees, and was a member of the Board of Governors of the New York Chapter.

His activities in other organizations were outstanding. He was a member of the Heating Boiler Division of the *American Society of Mechnical Engineers,* and the Boiler Code Committee of the *Steel Heating Boiler Institute.*

He is survived by his wife and two daughters, his mother, four sisters, and two brothers.

A leader in his chosen line and a loyal and faithful member of the Society, his memory will long survive him. The death of Raymond Newcomb is not alone a great loss to the Society, but to the community in which he lived.

The Officers and Council of the Society express their sincere sympathy for the loss of their beloved member.

Albert A. Cryer Dies

Albert A. Cryer, a charter member and one of the organizers of the Society, died on Sunday, January 31, 1932.

Mr. Cryer was one of a group of stalwart men connected with the heating industry who had the vision to see the necessity for encouraging its development along scientific lines, and to organize and promote the welfare of a society dedicated to that purpose. It took courage and determination to carry on in the face of discouraging obstacles, but their efforts have been justified; for the Society, today, ranks high in scientific achievement, and has won international renown and respect. From 1894-1898 Mr. Cryer served as a member of the Council.

Mr. Cryer will long be remembered in the hearts of those whose admiration and respect he has always held, and who share with his widow, Mathilde Helen, and son, John A. Cryer, in their great sorrow.

At the time of his death Mr. Cryer was president of the D. G. C. Trap and Valve Co., New York, N. Y.

Local Chapter Reports

Kansas City

January 15, 1932. The regular meeting of the Chapter, which was postponed until the 15th in order to take part in the general meeting of the Kansas City Engineering bodies sponsored by the local section of the *A. S. M. E.*, was held in the dining room of the Kansas City Athletic Club.

Dean A. S. Langsdorf, Washington University, St. Louis, was the speaker of the evening, presenting some new and original ideas regarding the control of the smoke nuisance in cities. His presentation was most interesting as well as entertaining.

The attendance at this meeting was unusual—both the Chapter members and the *A. S. M. E.* contributed their full share to the success of the meeting, which has now become an annual affair. This combining of both societies creates a feeling of good fellowship among the entire engineering group, and means much to everyone both socially and professionally.

Massachusetts

January 4, 1932. E. D. Milener, industrial research representative of the *American Gas Association* in New York, gave a very interesting presentation on the Application of Gas Heat Energy to Year 'Round Air Conditioning, before the Massachusetts Chapter meeting held at Durgin-Park's Hayward Place Restaurant.

F. R. Ellis introduced Mr. Milener, who outlined the development of winter and summer air conditioning for homes using gas heat energy. He gave a description of the apparatus used in two homes in which test installations have been made, and stated that since these test installations were made a year ago, the size and the cost of equipment had been reduced by half.

Mr. Milener expressed the opinion that some other measures than effective temperature seemed to be required for summer comfort conditions for the results in commercial installations using silica gel for dehumidifying indicated occupants and patrons were quite comfortable under conditions that do not fall within the summer comfort area of the A. S. H. V. E. effective temperature chart. Maintaining no lower temperature indoors than out, but greatly reducing the humidity by silica gel resulted in satisfactory conditions according to the survey.

Pres. David Moulton presided over the 44 members and guests present, all of whom showed their interest in Mr. Milener's subject by the discussion following his remarks.

Michigan

January 18, 1932. The Detroit Edison Co. was host to the 90 members and guests of the Michigan Chapter who gathered in the auditorium where Pres. G. H. Giguere called the meeting to order.

Following the routine business H. C. Kappler discussed the problem of free engineering by manufacturers of equipment, which was followed by a motion presented by L. E. Rollins:

> RESOLVED, that the Michigan Chapter of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS place itself on record as disapproving the practice of manufacturers and sales agents in furnishing free engineering layouts and specifications to contractors and architects, and be it further resolved that those so doing be requested by the Chapter to discontinue this practice, and that the Secretary be instructed to send copies of this resolution to the National Secretary of the Society.

President Giguere called for a vote and the motion was passed. He then turned the meeting over to J. H. Walker, who introduced the speaker of the evening, C. H. Hirshfeld.

Mr. Hirshfeld gave an illustrated lecture on What Next? His lecture dealt with the past and future development of steam power plants, which he illustrated both by models and lantern slides.

At the conclusion of Mr. Hirshfeld's talk the members and guests were entertained with vocal numbers and readings. Three basket ball games were played by members and a balloon-breaking contest was participated in by the majority of those present.

The meeting was then turned back to President Giguere, who called for a vote of thanks to The Detroit Edison Co.

Western Michigan

January 11, 1932. The January meeting of the Western Michigan Chapter gave further evidence of an increasing interest and membership in the Chapter, 40 members and guests having assembled in the English room of the Rowe hotel, Grand Rapids. Engineers from several Michigan state institutions were among those present.

Prof. H. B. Dirks, dean of the Engineering College, Michigan State College, expressed his interest in the Chapter activities and offered the cooperation of the technical facilities of the college.

The Chapter passed on a resolution providing for Limited Memberships, under certain conditions, which will offer increased interest and a greater stability to the acceleration of full membership to the Society and Chapter.

E. N. McDonnell, Chicago, spoke on the "Feed for Thought" with boiler feeder design, application and operation. E. H. Davis of Battle Creek followed with an explanation of piston and centrifugal boiler feed pumps and their application. After an open discussion the meeting was adjourned.

December 14, 1931. Thirty-eight members and guests gathered at the Rowe hotel, Grand Rapids, for the December dinner meeting, which was presided over by Pres. O. D. Marshall.

A general business discussion, followed by the appointment of the standing committees, started the Chapter off on what appears to be a very happy and successful journey.

S. S. Sanford, Detroit Edison Co., Detroit, spoke in a very pleasing and fascinating manner on Modern Methods of Saving Heat in Buildings, illustrated with stereopticon slides. The subject was one of general interest to all and bore considerable emphasis because the authority of the conclusions that were advanced was taken from observation of practical operations.

November 10, 1931. A Charter was granted on November 9, 1931, to a group of members in Western Michigan, hereafter to be known as the Western Michigan Chapter.

The initial dinner and meeting was held at the Rowe Hotel, Grand Rapids, and was conducted by temporary chairman, O. D. Marshall. The Chapter Constitution and By-Laws were read, discussed and adopted. A nominating Committee announced candidates for officers, and an election was held, resulting in the following:

President—O. D. Marshall
Vice-President—D. L. Taze
Secretary—C. H. Alexander
Treasurer—K. L. Ziesse
Board of Governors—W. W. Bradfield, W. J. Carroll and E. L. Jaynes.

The Chapter was fortunate in securing the presence of the following members of the Michigan Chapter, G. H. Giguere, E. H. Clark and W. G. Boales, who willingly made the trip to give the newly organized Chapter the benefit of their experiences in Chapter work.

A very timely and interesting talk was given by W. H. Tracy,

meteorologist, official in charge, U. S. Weather Bureau, Grand Rapids, on Weather Bureau Fundamentals and Practices.

After an open discussion the meeting adjourned with a positive assurance of the successful venture of the Society's adolescent Chapter.

Ontario

February 1, 1932. The regular meeting of the Ontario Chapter was held in the Ball Room of the Prince George Hotel, where 76 members and guests were in attendance. The Chapter had as its guests for the evening the members of the *A. S. M. E.*

E. Holt Gurney introduced the principal speaker of the evening, Prof. E. A. Allcut of the mechanical engineering department of the University of Toronto, who gave an illustrated lecture on Concealed Radiation. His address covered experimental data which were obtained from a large number of tests performed by the University.

Following Professor Allcut's talk the meeting was thrown open for discussion, which proved to be very instructive. A vote of thanks was extended Professor Allcut for his splendid address.

Philadelphia

January 14, 1932. The annual meeting of the Chapter was held at the Arcadia Cafe, where a large attendance was present to enjoy a fine dinner and entertainment.

After dinner President Sanbern presented the nominations for Chapter Officers and Board of Governors, as prepared by the Nominating Committee, and on motion duly seconded and carried, the following were elected to serve during the year 1932:

President—L. C. Davidson
Vice-President—M. F. Blankin
Secretary—W. P. Culbert
Treasurer—J. H. Hucker
Board of Governors—E. N. Sanbern, H. F. Rettew and W. R. Eichberg.

President Sanbern was presented with a very handsome electric clock by the members of the Philadelphia Chapter in appreciation of the services that he performed.

The meeting was then turned over to Mr. Hucker, chairman of the Meetings Committee, who presented an enjoyable evening of entertainment, part of which was supplied by members of the local Chapter, one feature being the Tall-Story Contest, the winner of which was H. H. Erickson. At the conclusion of the entertainment the meeting was adjourned.

Western New York

February 6, 1932. A large attendance of members of the Western New York Chapter and their wives helped to make the Annual Dinner Dance a great success. This was also the occasion of the installation of the new officers, who were called upon for short speeches.

Pres. Myron Beman appointed Roswell Farnham official toastmaster and at the conclusion of the evening those present felt that this annual social gathering was well worthwhile due to the creation of a closer bond of friendship.

The Program Committee is now working toward the completion of arrangements for interesting technical discussions at the three remaining spring meetings.

St. Louis

February 3, 1932. Pres. J. M. Foster presided at the February meeting of the Chapter held at the Roosevelt Hotel.

After all business had been attended to, J. W. Cooper of the Program Committee introduced Arthur Hardgrave, President of City Ice Co., Kansas City, who made the trip to St. Louis to present his paper on the subject of the Use of Ice in Space and Comfort Cooling. He described the general results of his experience in both the wet and dry method of the use of ice in cooling, which covered the use of manufactured ice to replace mechanical refrigeration on comparatively small installations.

Upon completion of his paper, Mr. Hardgrave answered many questions put to him, and a rising vote of thanks was given him by the 33 members and guests present.

Illinois

February 8, 1932. A meeting of the Illinois Chapter was called to order by Pres. J. J. Aeberly in the Rose Room of the Hotel Sherman with 88 members and guests present at dinner and 145 in attendance at the meeting.

W. H. Carrier, who was in Chicago for a short time between trains, was introduced from the floor and stated that he appreciated the opportunity of being at the Illinois Chapter meeting.

The subject of the new Constitution and By-Laws was then brought up and the amended form of this document was passed by an unanimous vote.

John Howatt spoke briefly, giving his impressions of the Society's Annual Meeting in Cleveland and mentioning specifically several technical papers, which he thought were of particular importance and interest.

E. A. Jones, L. J. Mueller Furnace Co., who is President of the Wisconsin Chapter of the Society, was introduced briefly as the speaker of the evening by President Aeberly. Mr. Jones spoke on the subject of Air Conditioning, pointing out its various phases, particularly in its application in the home. He stressed the importance of good engineering in air conditioning plants and the necessity of placing the responsibility with the Engineer, rather than with the Architect or Manufacturer. Mr. Jones supported engineering practice with practical experience and, at the conclusion of the discussion which followed, it was voted that Mr. Jones be given a vote of thanks for his fine address.

Minnesota

February 15, 1932. Fifty-two members of the Minnesota Chapter gathered in the Minnesota Union at the University of Minnesota to hear Prof. F. B. Rowley, President of the A. S. H. V. E. and a member of the local chapter, as the principal speaker of the evening. The meeting was presided over by Pres. H. E. Gerrish.

Following dinner, Mr. Lee, associate editor of the Minneapolis Journal, presented a very interesting view on Smoke Abatement. Mr. Lee requested the cooperation of the Chapter in this work and outlined how the daily papers, by means of editorials, were trying to do their part. The objects of these editorials were cited as follows: to arouse the people to the menace of smoke; to point out how it can be eliminated; and to arouse public sentiment to force the elimination.

President Gerrish spoke of the progress made in the membership drive and stated that 13 new names had been added to the roster during the season.

The members were advised that at the March meeting, Arthur Hardgrave, president, City Ice Co., Kansas City, Mo., will speak on The Use of Ice in Space Cooling.

C. E. Lewis, representative on the Nominating Committee, told of some of the high-lights of the Society's Annual Meeting in Cleveland and the value of attending these sessions.

President Rowley was introduced by S. A. Challman and spoke on Looking Forward in Heating and Ventilating. In considering the requirements for ventilation and air conditioning, President Rowley stated that a knowledge of the factors of ventilation are most important. These factors or atmospheric conditions affecting comfort and health can be grouped according to their importance. The primary or most important factors in the physiological effects upon the occupants are temperature,

humidity and air motion. As there are no optimum air conditions for comfort and health, the apparatus must be so designed that it can be readily adjusted for the required conditions. President Rowley predicted that great strides will be made in the future in the development of apparatus for the cooling of homes, trains and public buildings. President Rowley based his discussion of the advancements to be made in heating and ventilating largely upon investigations carried on at the A. S. H. V. E. Research Laboratory and cooperating institutions.

A rising vote of thanks was given President Rowley for his very interesting and instructive talk.

January 18, 1932. A meeting of the Minnesota Chapter was held at the Minnesota Union, University of Minnesota, with an attendance of 49, and was called to order by Pres. H. E. Gerrish.

The subject of the evening was New Developments in the Application of Copper Pipe and Fittings and was presented by three speakers, who were introduced by Carl Gausman.

L. H. Hummell, Standard Sanitary Mfg. Co., spoke on copper fittings.

The subject of copper pipe and fittings was discussed by H. H. Taylor, Mueller Co.

D. W. Hickey, Healey Plumbing Co., spoke on servicing and installation.

The speakers gave some very interesting facts regarding copper pipe and fittings, such as, the development, manufacture, distribution among the various industries, comparative costs of materials, etc. A demonstration followed, showing the amount of work and time required to make a joint.

The response to the discussion showed the interest of the members in this subject.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 3 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by March 15, 1932, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
OAKEY, WILLIAM E., Babcock Mfg. Co., Leonardsville, N. Y.	I. T. Bennett M. G. Steele	W. F. Goodnow F. G. Tallman—*ASME*
RAY, LEWIS BANKS, Manager, Ray Engrg. Co., Newark, N. J.	A. A. Adler W. G. Kreitner	Bernhard Goerg H. E. Grossman
SPERLING, H. EDWARD, The Fred Christen & Sons Co., Toledo, Ohio.	E. A. Jones F. J. Hoersting	E. F. Chittenden C. H. Soderberg

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

EAGLETON, STERLING PAUL, Sales Engr., Carrier Engrg. Corp., Cleveland, Ohio.

GILFRIN, GEORGE FREDERICK, Westinghouse Electric International, Mexico City, Mexico.

ASSOCIATE

HENDRICKSON, JOHN JOSEPH, Asst. Chief Engr., Bryant Heater & Mfg. Co., Cleveland, Ohio.

JUNIORS

PFEIFER, OTTO JOHN, JR., Insulite Co., Minneapolis, Minn.

SMALL, BARTLETT RAY, Office Engr., Carrier-York Corp., Charlotte, N. C.

STUDENTS

AMUNDSON, LELAND ROMAINE, Research Fellow, Heating & Ventilation, University of Minnesota, Minneapolis, Minn.

HERRMANN, HAROLD C., Research Fellow, University of Minnesota, Minneapolis, Minn.

MAXWELL, GEORGE W., Student, Carnegie Institute of Technology, Pittsburgh, Pa.

PESTERFIELD, CHARLES HENRY, Research Fellow, Heating and Ventilating, University of Minnesota, Minneapolis, Minn.

PRICE, ERNEST HARRY, Student, Carnegie Institute of Technology, Pittsburgh, Pa.

SCHWERTFEGER, ANTON, Research Fellow, University of Minnesota, Minneapolis, Minn.

SWANSTROM, ALFRED E., 1444 Van Buren St., St. Paul, Minn.

Heating · Piping and Air Conditioning

EDITORIALS

» »

W. E. Wickenden, president of the *Case School of Applied Science,* summed up the need for never-ending education of the engineer in his opening address at the process heating conference sponsored by Case and the *Cleveland Engineering Society* last month. Professor Wickenden said:

"Every one concerned with the education of engineers recognizes the utter inadequacy of the four-year college course. If it were our only resource, we should never be much more than a half-educated profession. The crux of the problem of educating the engineer lies in the fact that there are so many kinds of him. Basically, there is only one kind of physician, one kind of dentist, one kind of lawyer, one kind of architect. It is a fairly simple thing for experts within each of these professions to set down a schedule of what a novice needs to know in order to be admitted to professional practice. It is just the reverse with engineers; their name is legion.

"A few years ago, the editor of an engineering periodical undertook to take a census of individual types of engineers, real and so-called. He ran up to about 120, I believe, and was still going strong when death overtook him. Almost no boy in an engineering college can tell in advance what kind of engineer he is going to become, or is willing to take the risks of permanent specialization before he has had a chance to try out the field. The college can only give him a good family connection, and leave him to work out an individuality for himself. Keeping the boys longer in college might help them to get a broader general education, but only a few would get much nearer to their actual life work.

"It is clear that if we are to provide a more adequate professional training for the engineer, we must do most of it in the period after he has left school or college. Our engineering societies are recognizing this and are taking more and more responsibility for the after-college education of the engineer. In doing so they are returning to their original purpose.

"Two quite distinct phases of this problem need to be recognized. One is the early period after graduation when the novice is growing up and becoming of age professionally. A movement is now taking shape whereby the national organizations will probably lay down educational guide lines for this period, to culminate in a plan of individual examination and certification of professional standing. The second phase is the period of adult education for the mature engineer.

"All the scientific professions are finding it necessary to provide highly specialized clinical training for this mature member. An up-to-date dentist, for example, is likely to attend three brief and intensive clinical schools every year. An officer in the army will spend, on the average, one seventh of his time in service schools. If any needs this type of education, it is the engineer. The science and art are making strides almost too fast for the unaided individual to keep pace with; new specialties are developing almost over night; men are making new connections and having to master new fields. A good slogan for the profession would be 'Back to school at least once a year.'

"This is the job that the *Cleveland Engineering Society* and Case school are tackling together. I do not think either of us could do it properly apart from the other. It is an excellent thing for professors to have a hand in such a job as this and I am sure it is a good thing for educators to give the layman and practitioner something more concrete to do than to stand on the side lines and criticize. It is a good thing for industries to get into this teamwork with the college and the engineering society, for it takes the edge off mere ballyhoo and turns publicity into real education. Finally, it is a grand object lesson for students, a demonstration that the only place for an engineer who has a really finished education is in the cemetery."

The meetings of the engineering societies, the conferences such as those sponsored by Case, extension courses presented by a great number of colleges and universities, and the opportunities offered by many of the trade associations give the engineer a valuable opportunity to continue his education. Trade and technical papers and magazines offer further opportunity to the engineer to keep in close touch with the advances in his profession. There is no end of facilities; the responsibility of utilizing them to his own advantage rests to a large extent on the individual.

« «

» » » Put Valves Upside Down?

Says W. H. Wilson:

WE HAVE always tried to avoid placing a large valve with the bonnet and stem in a downward position. Some years ago we had some valves "upside down" and our experience warrants us not repeating this method of installation.

When a valve is installed with the bonnet and operating stem in the downward position, scale, rust, dirt, condensation, or foreign matter may collect in the pocket formed by the bonnet casting. Unless a valve is operated frequently, it is a difficult operation to move the valve stem by using the hand-wheel. Valves in this position are difficult to keep tight and free from leakage at the stem packing box, especially on steam lines. New packing cannot be inserted as conveniently as when the valve is in an upright position.

On the other hand, some operating men say that when the packing box is on the lower side of the valve, the water from the condensation of the steam keeps the packing wet and the packing lasts longer than if it is in contact with the hot steam.

As for scale and rust collecting in the bonnet, the counter-claim is that when the bonnet is in the upright position, the scale collects in the lower part of the valve body, between the seat rings. Gate valves with a clean-out pocket on the bottom and on the side allow the valve to be cleaned when installed in an upright position, provided the valve is accessible.

Gate valves used on underground water lines are usually installed in an upright position. (Some large ones are installed in a horizontal position.) When mud and scale collects in the bottom part of the body casting, between the seating rings, it can be flushed out by partially opening the valve and allowing the water to flow through. (See *Practical Piping Problems,* p. 724, under the caption "Opening a Water Valve," August, 1931, HEATING, PIPING AND AIR CONDITIONING.)

The sketch shows the hand-wheel of the valve a short distance from the floor. I have known men who were opening or closing valves that were installed in this position, to become confused as to which way to turn the hand-wheel. Counter-clockwise, on the spur of the moment, may appear to be clockwise.

Installing a gate valve in a vertical pipe line, with the stem at right angles to the piping, will eliminate the dirt and water pockets, in the lower part of the body casting and the bonnet.

Says F. E. Wertheim:

Some engineers who design hydraulic systems believe that the breakage of a valve stem may cause disaster if the stem is placed vertically, hence they are careful to have valves placed with horizontal stems. Valve manufacturers probably consider this a needless precaution.

Although one ordinarily finds gate valves placed either with horizontal stems or with the hand-wheel above the center line of the pipe, exceptions may be found in several of the finest central stations. The writer observed one or two valves, stem down, when visiting State Line Generating Station, near Hammond, Ind., designed by Sargent and Lundy, Inc. On inquiry, it was stated that the designers never place valves "upside down" on either main steam lines or headers, but if a valve located elsewhere becomes more readily accessible in any location where a ladder or platform might not be advisable they find no objection to placing the stem in the downward position. They might, for instance, place a valve with the stem down in a low pressure extraction line between turbine and heater.

In making piping layouts, the writer has several times found occasion to show one or two valves stem down. In each case it was deemed expedient to make changes and to avoid the criticism of those who asserted that "It simply is not done."

Removing Moisture from Air Piping

"Open for Discussion"

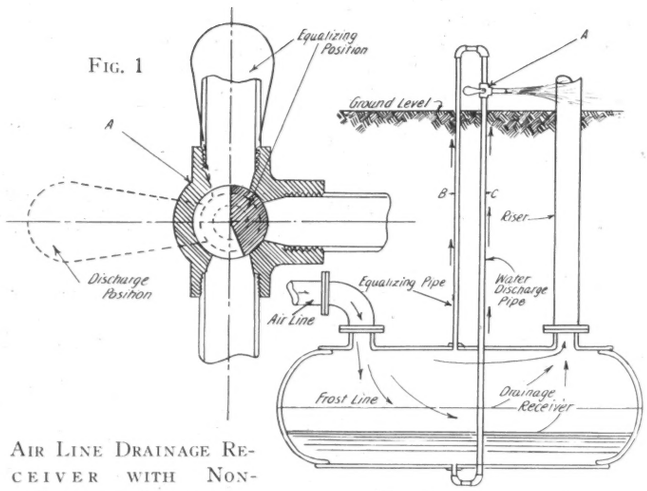
I WAS interested in the article, "Installing Industrial Air Piping," which appeared in a recent issue[1]; it is sound and makes some good points.

It seems to over-emphasize the possibility of condensing water in the receiver located at the compressor. There is usually some condensation in such a receiver, especially of oil, but usually only a small fraction of the possible water moisture. The practical way of removing water vapor is by condensing it by cooling the air. Unless after-coolers are used, the air is usually at a high temperature for a considerable distance of the pipe line. A cubic foot of air (or more exactly a cubic foot of space) has about eight times the capacity for carrying uncondensed water vapor when the temperature of the space is 150 F as it has when it is at 75 F. Usually there is no condensation in an air line until the temperature has fallen below 150 F. For this reason it is of aid to place water separating devices near the points where the air is used.

As supplementing the information on receiver installation, the arrangement shown in the sketch is of interest. In many applications, such as railroad, mine, quarry, etc., the lines are buried under ground and are of considerable length. The line condenses most of the water vapor. At the point of use, the line comes up out of the ground. Before putting on the riser, it is well to have a drainage tank located at or near frost line. A pipe *C* connected to the bottom of the receiver will draw the water from the bottom of the tank. However the water will freeze in pipe *C* in cold weather and then there is no drain. The piping shown—pipes *B* and *C* with valve *A*—permits blowing out the water with the valve handle in the position shown in Fig. 2. Then when the valve is turned to the position shown by the full lines in Fig. 1, pipes *B* and *C* are connected and the water in pipe *C* runs back into the tank where it is safe from freezing.—*C. A. Dawley*, chief engineer, New Jersey Meter Co., Plainfield, N. J.

[1] See "Practical Piping Problems," HEATING, PIPING AND AIR CONDITIONING, November, 1931, p. 985.

FIG. 1



AIR LINE DRAINAGE RECEIVER WITH NON-FREEZING BLOW-OFF

FIG. 2

Formulas for Economical Thickness of Insulation Corrected

Owing to the author's absence when the final page proof of the article "Method and Charts for Determining Economical Thickness of Insulation" (January, 1932, p. 6) was sent to him for approval, a few typographical errors were made which he was unable to correct. These errors were of minor importance but are corrected and explained below.

1. At the bottom of page 7, in the first bracket, insert t in the expression Δ'_o to read $\Delta t'_o$.
2. At the bottom of page 9, left hand column, in the (b) $K_1\Delta t'_1$ expression, delete the prime (′) to read (b) $K_1\Delta t_1$.
3. At the middle of page 9, right hand column, third line of second tabulation, insert prime (′) to read $K_o\Delta t'_o = 318$ instead of $K_o\Delta t_o = 318$.
4. In middle of page 10, left hand column, in second expression for net saving, change A to a to read in bracket,

$$\left[ln_e \frac{R}{r} + \frac{a}{R} \right]$$

5. At bottom of page 10, left column, in last two formulas, change 10^6 to read 10^{-6}.

Practical Piping Problems

Operating Industrial Steam Piping

W. H. Wilson's Monthly Discussion of the Problems He Meets From Day-to-Day

Steam for process and heating in industrial plants often is not required continuously. If the lines for conveying such steam are extensive in length, not provided with the proper hangers and supports to insure correct alignment, or have many changes in direction and inadequate means of removing the condensation that accumulates when a cold steam main is put in service, considerable maintenance work is involved.

When a line changes from a horizontal to a vertical water-hammer is likely to occur when condensation is large. Machinery, shafting, overhead cranes and other obstructions also necessitate changes in direction of the piping and it will be anything but a straight line. General practice is to install steam traps at the low points to remove the condensation.

When steam is turned on a main of this type, the condensation accumulates quickly, because of the low temperature of the piping, and may overload the traps. This frequently results in water-hammer that causes the main to "kick" and "pound"; unless a drain is opened to relieve the condition, broken fittings and damage to the pipe line will result.

Turning Steam on Fast Eliminated Water Hammer

Fig. 1 shows a line supplying 100-lb. steam which is not in use over the week-end and is turned on prior to the regular starting time on Monday. The steam trap and drain, *A*, are located in a tunnel and are not readily accessible. When steam is turned on this line slowly,

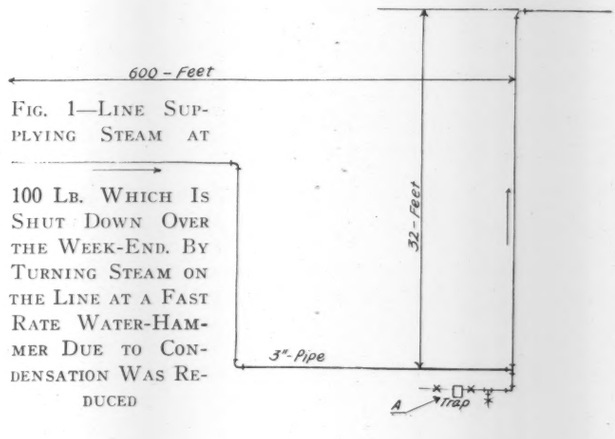


FIG. 1—LINE SUPPLYING STEAM AT 100 LB. WHICH IS SHUT DOWN OVER THE WEEK-END. BY TURNING STEAM ON THE LINE AT A FAST RATE WATER-HAMMER DUE TO CONDENSATION WAS REDUCED

according to general practice, a violent pounding and water-hammer results and it is necessary to enter the tunnel and open the drain to relieve the condensation accumulating in excess of what was being discharged by the trap. By turning steam on this line at a faster rate the water-hammer is slight, not enough to be considered, and it is not necessary to open the drain valve. The rate of turning on the steam depends on the initial pressure and the temperature of the pipe. This can be best acquired by experience and practice with the particular pipe line.

Changing from Exhaust to High Pressure Steam Caused Trouble

Fig. 2 shows the pipe lines supplying the heating system of a large industrial building containing 28,000 sq. ft. of direct radiation. The low pressure main used principally for exhaust steam during regular working hours is shown at *A* and the high pressure steam main for supplying steam when exhaust steam is not available is shown at *B*. The high pressure steam is admitted to the heating system through the reducing valve *C*. The low pressure main leading to the building is of considerable length and installed in an outside tunnel. Owing to conditions regarding location, room is limited where the pipe passes under railroad tracks, which affects the alignment of the piping. The outside main is not thoroughly drained, condensation accumulating at the low points.

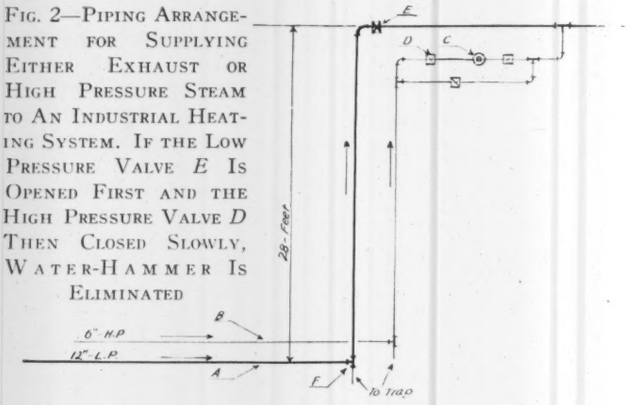


Fig. 2—Piping Arrangement for Supplying Either Exhaust or High Pressure Steam to An Industrial Heating System. If the Low Pressure Valve *E* Is Opened First and the High Pressure Valve *D* Then Closed Slowly, Water-Hammer Is Eliminated

When changing from high pressure to low pressure steam, the following was experienced: By closing the valve *D* first, the steam was shut off of the high pressure supply. In cold weather, when the demand for steam for the heating system was great, the interval of time between closing the high pressure supply valve *D* and opening the low pressure supply valve *E* allowed a partial vacuum to form in the heating system. When the low pressure steam supply valve was opened this caused a heavy flow through the low pressure main and carried the condensation to the point *F*, overloading the trap and causing a water-hammer. If the low pressure valve *E* is opened first, when changing from high pressure to low pressure steam, and the high pressure valve *D* then closed slowly the water-hammer is eliminated.

Reservoir Cares for Condensation

Fig. 3 shows a 12-in. low pressure steam main equipped with a pocket or reservoir, *A*, to take care of the excess amount of condensation that collects when a steam main is put in service, or when water is carried over in the main from other causes.

The capacity of this reservoir depends on the length of the steam main and the other factors which affect the amount of condensation that may accumulate. The length, size and arrangement depends on the room available in the tunnel or basement where the main changes to a vertical direction. The capacity of ten or twelve feet of pipe the size of the main will usually be sufficient. The reservoir should be below the main so the condensation will flow to it by gravity. The method shown permits a free flow of the steam and allows the condensation to separate and go directly into the reservoir.

This reservoir is drained by the trap *B* and is also provided with a drain valve *C* which can be opened in case the trap or return line are not in service. A large thermostatic trap *E*, not provided with a shut-off valve and discharging to the atmosphere, is located above the regular trap. In case the trap *B* or the return line should be shut off by mistake, the water of condensation will rise in the reservoir and pass out through the thermostatic trap, which is ordinarily kept closed by the temperature of the steam. The thermostatic trap is, in this case, a relief trap for emergency use.

When the main is not in service and the return lines are connected to a vacuum system there is a possibility of air being drawn into the return lines through the supply main if the drain valve is left open. The check valve *D* will prevent a back flow of air in this case. For the same reason a check valve *F* is used in connection with the thermostatic trap, as traps of this type will open when the temperature decreases.

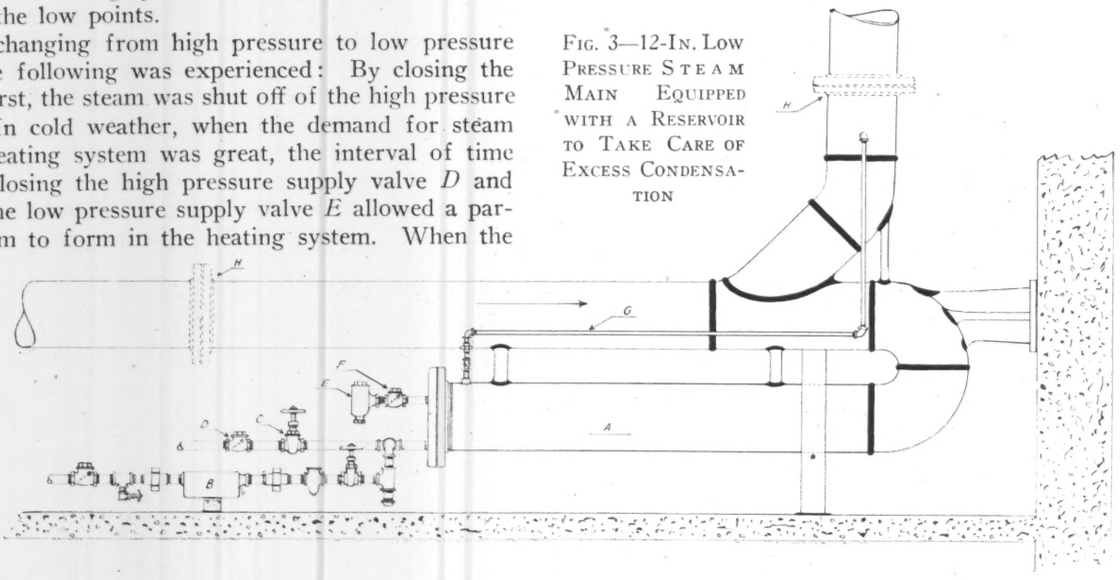


Fig. 3—12-In. Low Pressure Steam Main Equipped with a Reservoir to Take Care of Excess Condensation

A 1-in. pipe connection is shown at *G* to remove the air from the reservoir by venting it in the upper part of the main when water enters the reservoir.

Flanged joints may be placed in the piping at *H*. In case it is necessary to remove the piping for repairs the flanged joints may be conveniently separated and the entire section of piping lifted out of the tunnel. The reservoir as well as the remainder of the piping should be well insulated to prevent heat losses.

High pressure steam lines may be equipped with similar reservoirs and the same general design can be followed, the reservoir being in proportion to the size of the pipe line. The thermostatic trap should be suitable for the pressure and temperature.

Putting Loop Mains in Operation

Loop or circuit mains, where steam is supplied from both ends, should be given special consideration when being put in service. It is usually safer to turn on steam from one valve and drain the condensation near the valve at the opposite end. When the entire section of the main is full of steam and the pressure equalized, the division valve can then be opened.

A case is recalled where two boiler houses, 1,500 feet apart, were connected by an 8-in. pipe line, located overhead on supports. Each operating man started to open his valve, for turning on the steam, at the same time. An instant later a length of pipe in the line was ruptured midway between each supply valve.

The shutting off of steam mains for short periods, such as overnight, should be given careful consideration. A well-insulated pipe line can be kept warm over night at low cost by reducing the steam pressure. For a short period the cost may compare favorably with shutting off completely. For periods of several days or weeks, it would be a different proposition, of course.

Changing the Nomenclature of Heating Engineering*

IT HAS been said that the eccentricities of every man's religious belief are perfectly obvious to everybody but himself. But before you point them out to him, be sure that what you have to substitute is more logical and more effective. The same thing applies to changing the nomenclature of heating engineering.

Boilers were used for many years before the definition of the standard boiler hp. was established. The boiler may be water tube, return tube, flash boiler, etc. The specification of type, hp., and efficiency would seem to me to cover the requirements.

A heater means to me, a "combustion chamber" for any kind of fuel, and an "interchanger."

The "interchanger" may be used alone for the transmission of heat from one fluid, whether steam, oil, water or gas, to another fluid, either water, oil, air or gases. It seems to me that "interchanger" is more expressive than "transmitter" or "generator."

"Grille" is, of course, more logical than "register face."

It seems to me that a heating unit of any type should be designated by type, actual surface, and effective capacity, at least until some new and comprehensive scheme of designation has been developed that is more indicative, and which will fit all types of heat emitters, whether exposed or concealed and whether they work by radiation or convection or both.

It is no hardship to write Btu and everybody knows what is meant. To say simply "heat unit" is not clear. A calorie is also a heat unit.

But when it comes to *Elecon* it sounds like a confidence game, or like saying "eremacausis" when you mean "rusting." I will admit that a longer designation may not always be more clear than a single word. According to Johnson's dictionary a "network" is a "reticulated fabrication with interstices between the intersections." Perfectly clear, but inconvenient; I'd rather specify a wire netting.

I would hate to see the nomenclature of heating engineering approach that of chemistry and medicine, all heating specifications beginning with B followed by a jumble of terms; and when it comes to suddenly changing the *whole* nomenclature of a profession, with one fell swoop, I have my doubts.—*B. S. Harrison,* Chief Engineer, Nichols Products Corporation.

Conventions and Expositions

Air Conditioning Conference: To be held at Case School of Applied Science March 17-19; sponsored by Case and Cleveland Engineering Society. Chairman, G. L. Tuve, Dept. of Mech. Engrg., Case School of Applied Science, Cleveland, Ohio.

American Oil Burner Association: Annual convention, April 11-16; Mechanics Building, Boston, Mass. Secretary, H. F. Tapp, 342 Madison ave., New York City.

American Welding Society: Annual meeting, April 27-29; New York City. Secretary, M. M. Kelly, 33 W. 39th st., New York City.

Heating and Piping Contractors National Association: Annual convention, May 16-18; Book Cadillac Hotel, Detroit, Mich. Secretary, Joseph C. Fitts, 50 Union Square, East, New York City.

American Boiler Manufacturers Association: Annual convention, May 23-25; Greenbrier Hotel, White Sulphur Springs, W. Va. Secretary, A. C. Baker, 801 Rockfeller Bldg., Cleveland, Ohio.

National Electric Light Association: Annual convention, June 6-10; Atlantic City Auditorium, Atlantic City, N. J. Secretary, A. J. Marshall, 420 Lexington ave., New York City.

National District Heating Association: Annual convention, June 14-17; William Penn Hotel, Pittsburgh, Pa. Secretary, D. L. Gaskill, Greenville, Ohio.

American Society for Testing Materials: Annual meeting, June 20-24, Atlantic City, N. J.; Cleveland regional meeting, March 9; group meetings of commit-

*A discussion of "Suggested Reforms in Heating and Air Conditioning Nomenclature," by S. R. Lewis. HEATING, PIPING AND AIR CONDITIONING, September, 1930, p. 744.